INTELLIGENT AGENTS FOR ON-LINE LEARNING

By

Choonhapong Thaiupathump

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Approved:

Prof. John R. Bourne - Chair

Prof. Arthur J. Brodersen

Prof. Richard G. Shiavi

Prof. Donald Z. Spicer

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CHAPTER I

INTRODUCTION

This work investigates possible effects of adopting intelligent agent techniques to an on-line learning environment. The primary interest of the study is to scrutinize how to effectively adopt intelligent agent technology to improve the quality of Asynchronous Learning Networks (ALN) courses. ALN courses are instructor-led on-line courses delivered via the Internet. Improving the quality of ALN courses can be perceived in many different ways, such as improving retention, lowering cost, and improving learner satisfaction. Specifically, for this study, retention rate is used as the prime measure of quality improvement since retention rate is one measurable and unambiguous outcome measure.

Intelligent agents, in general, incorporate the ability to automate tasks on a human's behalf, incorporate *a priori* knowledge and work to complete tasks. Intelligent agents for on-line learning should be able to provide mechanisms that help the on-line learners achieve learning goals as well as improve retention, lower costs, and improve learner satisfaction.

Background

A traditional on-line course requires significant human effort to facilitate the course and to help learners to achieve the learning goals. This job is quite routine, but consumes a substantial amount of facilitation time. As a result, there is a need for creating automated tools that help improve the quality of teaching and facilitating on-line courses while reducing human effort.

As a guideline, intelligent agents for on-line learning should resemble some aspects of the activities that a facilitator would perform to assist on-line learners to learn effectively. Hence, these automated tools would be able to:

- Perform assignment checking tasks and provide immediate feedback
- Guide or tutor learners to complete assignments
- Encourage learners to complete the tasks

The ultimate goal of using these automated tools would be to improve the quality of on-line learning.

The idea has led to an interest in adopting intelligent agents to on-line learning. The intelligent agent is a relatively new research area within artificial intelligence (AI), and human-computer interaction (HCI). Despite the recent popularity of intelligent agent research, little has been done in the area of ALN. Thus, the purpose of this study is to investigate intelligent agent technologies and their utility for the ALN community.

In this study, a series of experiments were performed on the ALN Workshop environment because the capability for rapidly controlled experiments. The main objective of these experiments was to determine whether adopting intelligent agent techniques improves the learner retention in the workshops. Retention rate is a particular problem in on-line learning environments since learners are not together and are not as easily motivated as face-to-face learners. In addition, since this is an initial attempt to investigate the effect of an intelligent agent to on-line learning, it is also worthwhile to examine other outcomes that are possibly relevant to the use of intelligent agents. Those outcomes include determining whether or not the use of intelligent agent techniques reduces the facilitation cost and time and improves learner satisfaction.

ALN and On-line Learning

Due to the capabilities of the Internet, a number of institutions worldwide have adopted Asynchronous Learning Networks (ALN; also known as Net Learning or On-line learning) as a way of extending learning outside the classroom to both on-campus and off-campus students (Bourne, 1998). This number is growing rapidly.

Asynchronous Learning Networks (ALNs) are defined as on-line learning venues that emphasize people-to-people communication combined with traditional and/or information-technology-delivered learning tools (Source: ALN Web, http://www.aln.org). Asynchronous Learning Networks (ALN) has become a widely used term to describe on-line or net-learning experiences. In general, the goal of ALN has been to deliver on-line learning to anyone, anywhere and at anytime. Reaching more people while not decreasing quality has been the goal of the “Learning Outside the Classroom” program of the Alfred P. Sloan Foundation (Bourne, 1998).

Another definition of ALN is given by Hiltz and Wellman (1997) in the *Communication of ACM*, Sept 1997, p. 44-49.:

> An ALN is a teaching and learning environment located within a CMC (Computer-Mediated Communication) system designed for anytime/anyplace use through computer networks. ALNs consist of a set of group communication and work "spaces" and facilities constructed in software. They are virtual facilities for interaction among the members of a class, rather than physical spaces. ALNs are best at enriching educational options when they server as a way to create the feeling of a true "class" or group of people learning together to structure and support carefully planned collaborative learning activities that constitute the assignments for a course.

Bourne (1998) mentioned that in some ways ALN could be viewed as an outgrowth of research on technology-based education that has occurred during the past few decades. Work in this area includes Computer Based Training (CBT), intelligent tutoring systems, and computer-based cooperative work. Unfortunately, efforts in these areas have affected education in only minor ways (Bourne, 1998).

Rationale, Need for Agents, Problem Definitions

Many organizations are embracing ALN by offering courses on the World Wide Web, and the number is growing rapidly (Bourne, 1998). Since ALN has been becoming more and more used in on-line learning pedagogy, new technologies and research began to be adopted to improve the quality of the courses offered on-line. The new areas of research involve in a number of ways such as artificial intelligence and intelligent tutoring systems (Bourne, 1998).

Intelligent agent is a relatively new research area within artificial intelligence (AI) and Human-Computer Interactions (HCI). General purposes of intelligent agents are to assist humans in doing some routine tasks. Thus, there is a need for intelligent agents for ALN that can perform assignment checking on a human behalf as well as enhance the quality of the courses offered on-line. Improving the quality of an on-line course is defined as improving learning retention, completion rate, and learner satisfaction, and reducing the learning time. To satisfy those needs the agents must perform such tasks as facilitation, tutoring, and providing help as needed.

KnowBots for the ALN Workshop are computer programs that employ intelligent agent techniques to provide assistance to Workshop facilitators dealing with facilitation tasks as well as to workshop participants dealing with completing assignments. Sample tasks performed by the KnowBots for the workshop are:

- Perform assignment-checking tasks on a (human) facilitator's behalf.
- Periodically encourage participants to finish assignments.
- Providing the participants additional knowledge, guidance, suggestions and directions to assist them to complete the assignments.

By using the KnowBots, a student or a workshop participant is able to submit his or her assignment, and receive an immediate checking result associated with other helpful information to assist the participant completing the assignment.

The ALN Workshop, "Getting Started Creating On-Line Courses", is an on-line workshop offered by the ALN Web through the ALN Web site (http://www.aln.org). Each session of the workshop lasts about eight weeks. Participants of past workshops have been teachers and training professionals from higher education and the training industry. The goal of the workshop is to provide fundamental knowledge for the participants to be able to get started creating their own on-line courses. Participants who take the workshop are required to participate and complete the assignments totally on-line. A workshop participant is required to complete a total of eight assignments. Completion of each assignment is criteria based, rather than grading style or norm based. That means that the completion status is either pass or fail.

This study examined two groups of on-line learners (participants) in an on-line course (ALN Workshop), using the same learning materials, but with different type of learning assistance. One group participating in the workshop received help from KnowBots, and the other group did not. Attitudes, learning behavior, completion rate, partial completion rate, learner satisfaction, facilitators' time spent for each group are compared to assess the impact of the KnowBots as an automated assistance tool.

The major hypothesis is that adopting intelligent agent techniques to an on-line learning environment such as the ALN Workshop improves the completion rate of the workshop. Other hypotheses are the use of intelligent agent technology reduces the costs and time required to facilitate the workshop as well as improves learner satisfaction. To capture the benefits of these automated tools for ALN learning environment, a matrices of measurements was developed to test the hypothesis. The specific aims of the analysis are:

- To determine, through analysis, if adopting agent technologies to the ALN environment can provide a better or more effective learning environment
- To determine if the characteristics of the agent can be duplicated in an on-line industry. The aim is to understand how to improve on-line education by adopting these technologies to an ALN course.

The larger question is the effect of intelligent agents as assistants on on-line learning. The overall completion rate was used as a performance indicator, and the use of intelligent agent techniques was used as a device to discriminate among learners in each group, in order to:

- determine the impact of adopting the intelligent agent techniques to an on-line course (i.e., Does the use of intelligent agent affect completion rate?)
- detect any difference in outcomes (completion rate, learner retention and satisfaction) that might signal an interaction between learning style and the use of intelligent agents in the on-line learning environment (i.e., Does any particular attribute dispose a student to better performance using conventional on-line learning versus the use of intelligent agent?)

Evaluative methods were performed on data acquired from the past Workshops to compare and evaluate the effectiveness of the use of intelligent agents in the on-line learning environment. In addition, web-based questionnaires were sent to those participants to acquire additional data such as learner satisfaction, learner attitude, etc. The resulting data were analyzed based on the criteria proposed in the Methods section of this paper.

It is hoped that the results of this study will benefit the ALN community.

Increased Motivation for the Learners to Engage in On-line Learning

Distributed or on-line learning programs have historically presented low rates of completion (Campbell and Bourne, 1997). The learners often lost track of what they were supposed to do to complete their assignments or to accomplish the learning goals. To improve the completion rate, there needed to be some motivation for the learner to engage to the on-line material (Campbell and Bourne, 1997). A goal of adopting an intelligent agent to on-line learning is to motivate the learners and to increase the learners' engagement with the course.

According to Campbell and Bourne (1997), people are more likely to complete an on-line (or distributed learning) course that includes the following motivations:

- Scheduled, graded assignments with rapid feedback
- Required contributions to on-line conferencing discussions
- A team that works together on a project
- A cohort of learners who progress through a course together
- Course grade, certification, or other indicator of value.

Currently, a number of on-line courses provides the above motivations in a variety of ways, but only a few have managed to develop effective ways to provide "Scheduled, graded assignments with rapid feedback". In addition, Campbell and Bourne (1997) elaborated further that typical on-line learners are motivated by many factors like a need to know or use of the content, the value of the certification or a degree to qualify for a job, or a desire for a high grade point average.

Therefore, an automated tool that uses intelligent agent techniques would contribute benefit to on-line learning, if it can:

- Provide a rapid, accurate feedback on schedule
- Be invoked on demand
- Encourage the student to complete assignments or tasks in order to satisfy the requirement of the course or certification.

Reduced Information Overload

Typically, the contents of any on-line courses are likely to be constantly changing or dynamic. The overwhelming information volume in an on-line course with the inherited links to the Internet can easily cause the learners to get lost in the course material. One of many possible uses of an intelligent agent for on-line learning would be to assist learners to stay focused on the learning material by providing better help and giving explicit directions of where to look for certain information. As a result, it would help learners stay on the right track in the on-line course. The likely result is to reduce information overload for the on-line learner as well as reduced learner frustration during the course.

Reduced Cost and Time

A possible use of an intelligent agent with on-line learning is to assist the learners to learn more effectively. It should be able to help the learners to spend less time to finish the assignments or other requirements of the course. Another use would be that, with the agent, facilitators or instructors could respond to learners' questions faster. As a result, it could help reduce cost and time to instruct and facilitate an on-line course. Hence, there are two types of possible cost and time reduction by the use of intelligent agents: One is to reduce the learning time of the learners and the other is to reduce cost and time to facilitate the on-line course of the facilitators or instructors.

Goals of Research

The purpose of this study is to advance the theory, development, deployment, and assessment of intelligent agent techniques into the on-line learning environment. Possible reusability of such intelligent agent frameworks for an on-line course was explored. The goal is to determine ways to effectively adopt this infrastructure to on-line modalities.

An experimental study was conducted specifically on the ALN Workshop environment. The effectiveness of adopting intelligent agent techniques to an on-line learning environment such as the ALN Workshop was analyzed through a series of very specific experiments. Analyses of data were performed based on a set of criteria to specify the strategies of implementing and adopting the intelligent agent to on-line learning. Additional data were acquired through a survey questionnaire and data collected from workshop facilitators.

It is hypothesized that the use of KnowBots improves the completion rate of the workshop, as well as improving learner satisfaction, and reduces facilitation time. Therefore, the experimental study was created to test the above hypothesis.

Summary of Research

In the following review, it will be seen that a number of ideas and implementations of intelligent agents are described in educational or training environments. This information provides us with the foundation of what an agent might be capable of doing for an on-line learning. The emergence of intelligent agent technology as a new discipline and the development of concepts in adopting intelligent features provide us with new directions. These directions support the development of intelligent agents for on-line learning that are expressed using some of the widely accepted visual notation of intelligent agent software. The future holds promise for even more structured and formal approaches.

This work offers a new paradigm for building an intelligent software system that supports facilitation tasks for an on-line learning as a part of intelligent learning environment to improve the quality of ALN. The study specifically captures the experimental results of using the KnowBots in the two sessions of the ALN workshop. The KnowBots architecture draws from ideas of which tasks workshop facilitators normally perform and provides quicker and better support to the learners. This new infrastructure assists workshop facilitators in term of reducing the complication of routine tasks as well as reducing the number of tasks themselves. This kind of automation could provide a model where new intelligent components may be adopted to on-line learning in order to improve the quality of ALN.

Organization of Dissertation

The remainder of this document is organized as follows: Chapter Two investigates the role of intelligent agents and reviews a wide variety of intelligent agent applications and researches. The Chapter Two also includes the role and work done in Intelligent Tutoring Systems (ITS) since the ITS concept is considered closely relevant to the topic. Chapter Three presents the Method for the study. Chapter Four continues with Design and Implementation of the system. Chapter Five presents Results and Analyses of the study. Chapter Six consists of the Conclusions and Discussions.

CHAPTER II

BACKGROUND

In this section, literature pertaining intelligent agents and intelligent tutoring systems will be discussed.

Review of Literature on Intelligent Agents

The modern information environment has expanded exponentially over the last few years with the astounding progress of computer technology. Due to the enormous quantity and heterogeneity of information that has recently become available to the masses, intelligent agents have been introduced to mediate the flow of information and to reduce the overwhelming level of confusion. The agents represent the components in interactions, where they mediate differences and provide a syntactically uniform and semantically consistent medium (Huhns and Singh, 1997). At the same time, the complexity and dynamism of information environments has led to a pressing need for user interfaces that are active and adaptive personal assistants, or intelligent agents (Huhns and Singh, 1997).

Definitions and Characteristics of Intelligent Agents

A definition of intelligent agents is given by Lieberman (1997):

> An intelligent agent is any program that can be considered by the user to be acting as an assistant or helper, rather than as a tool in the manner of a conventional direct-manipulation interface. An agent should as well display some, but perhaps not all, of the characteristics that are associated with human intelligence: learning, inference, adaptability, independence, creativity, etc.

Lieberman (1997) also mentioned in his paper that (a) the agent operates in the interface, as opposed to in the background or "back-end" of an application (b) the agent acts autonomously, as opposed to having a sequential conversation with the user. Often, an agent will satisfy one or the other of these characteristics, but it is rare that it will exhibit both at once (Lieberman, 1997).

Another definition of intelligent agents by Selker (1994) is that they are computer programs that simulate a human relationship, by doing something that another person could otherwise do for you.

Etzioni and Weld (1995) defined the term “software agent” as a computer program that behaves in a manner analogous to a human agent. In essence, the term refers to software that supports a social interface metaphor -- a dialogue between a person and the agent. Etzioni and Weld (1995) summarized the following characteristics proposed by numerous researchers as desirable qualities of software agents:

- Autonomy: An agent initiative and exercise control over its own actions in the following ways:
  - Goal-oriented: accepts high-level requests indicating what a human wants and is responsible for deciding how and where to satisfy the requests.
  - Collaborative: does not blindly obey commands but can modify requests, ask clarification questions, or even refuse to satisfy certain requests.
  - Flexible: actions are not scripted; able to dynamically choose which actions to invoke, and in what sequence, in response to the state of its external environment.
  - Self-starting: unlike standard programs directly invoked by the user, an agent can sense changes in its environment and decide when to act.
- Temporal continuity: An agent is a continuously running process, not a one-shot computation that maps a single input to a single output and then terminates.
- Personality: An agent has a well-defined believable personality that facilitates interaction with human users.
- Communication ability: An agent can engage in complex communication with other agents, including people, to obtain information or enlist help to accomplish its goals.
- Adaptability: An agent automatically customizes itself to the preferences of its user on the basis of previous experience. It also automatically adapts to changes in its environment.
- Mobility: An agent can transport itself from one machine to another and across different system architectures and platforms.

Although no single agent has all these characteristics, several prototype agents embody a substantial fraction of them. There is little agreement about the relative importance of different properties, but most researchers agree that these are the characteristics that differentiate agents from single programs (Etzioni, 1995).

Applications of Intelligent Agents

Huhns and Singh (1997) investigated a number of intelligent agent applications and summarized that "there are numerous applications for agents. Many involve varieties of personal assistants, and others are specialized for information-rich environments. Still others involve topics such as art, drama, and design -- well beyond the traditional applications of computing, but increasingly important." (p. 5)

Intelligent Agents as Personal Assistants

One intelligent agent application is concerned with agents that work closely with a user, functioning as a personal assistant. Huhns and Singh (1997) described personal assistants that they may be characterized as

- Multi-modal: support interactions in different input and output modalities.
- Dialogue based: carry out a conversation, not necessarily spoken, with the user.
- Mixed-initiative: if dialogue based, let the user control the dialogue dynamically or make unexpected requests
- Anthropoid: endowed with a personality: typically emotional
- Cooperative: assist the user in defining the user's real needs -- this typically requires some ability to model the user and the task the user is engaged in
- Adaptive: learn from past interactions with the user

Traditional AI sought to develop automated tools that required some intelligence to help users in solving problems. Huhns and Singh (1997) reviewed the recent trend that rather than attempting to automate the reasoning process fully, tools are developed to assist humans in carrying out the reasoning. Some motivations for this trend are (Huhns and Singh, 1997):

- Many interesting problems are too complex to have tractable solutions that are fully automated.

- In many settings, for issues of ethics and responsibility, computers cannot be trusted to perform critical actions unilaterally. In such settings, it is crucial to keep a human in the decision loop.
- Some applications inherently require the active participation of a human because the problem cannot be specified in a form that will admit to automatic solution. An important case is information retrieval, where users typically do not have a precise query that can be processed automatically. Instead, users need to ask some leading queries to understand the information space that are searching and to formulate a precise query only gradually. Another example is education: it would be inappropriate with current technology to eliminate the human user from an educational system.

By following the above trend, KnowBots for ALN Workshop have been developed to assist the on-line learners and the workshop facilitators. Because of the similarity to an educational setting, the architecture of the KnowBots still requires the active participation of a human facilitator.

The environment of a personal assistant has two main components: the human user and the back-end information system. These two have different properties, which place some interesting requirements on the designs of the assistants. Table 1 (Huhns and Singh, 1997, p. 7) lists the key properties of users and back-end systems using the term introduced in Table 2 (Huhns and Singh, 1997, p. 3). An assistant is assumed to be able to find all that is relevant about the user and system. It may partially predict the user's behavior, which motivates having adaptive user modeling. Since the user is historical and teleological, dialogue functionality is required along with some task modeling. Since the assistant cannot control the user and users can change their minds in real time, it must allow interrupts. That is a mixed-initiative.

Table 1 A Personal Assistant's Environment

Property	**User**	**Backend System**
Knowable	Yes	Yes
Predictable	Partially	No
Controllable	No	Partially
Historical	Yes	No
Teleological	Yes	Maybe
Real time	Yes	Possibly

Note: From "Readings in Agents" (p. 7), by Huhns and Singh, 1997, San Francisco: Morgan Kaufmann Publishers.

Table 2 Environment-Agent Characteristics

Property	Definition
Knowable	To what extent is the environment known to the agent?
Predictable	To what extent can it be predicted by the agent?
Controllable	To what extent can the agent modify the environment?
Historical	Do future states depend on the entire history, or only the current state?
Teleological	Are parts of it purposeful (i.e., are there other agents)?
Real time	Can the environment change while the agent is deliberating?

Note: From "Readings in Agents" (p. 3), by Huhns and Singh, 1997, San Francisco: Morgan Kaufmann Publishers.

Information access

Information access, especially over open environments such as the Internet, has motivated some of the most significant applications to date. Etzioni and Weld (1994) showed how a Softbot could be an advanced interface to the Internet. Softbots are software robots, whose effectors and sensors are software utilities such as FTP and telnet. A Softbot has knowledge of various Internet utilities in terms of their inputs and outputs and can plan sequences on actions on behalf of a user. It can also dynamically re-plan when encountering unexpected changes in the Internet.

Kuokka and Harada (1995) described a matchmaker agent, which was a component of the medium through which application agents may be linked to information resources. The matchmaker used a rule-based framework and KQML (Knowledge Query and Manipulation Language) messages for a number of applications, including information access.

Models of Agency

Much of the research on agents has concentrated on the development of techniques for imbuing agents with abilities that mimic or complement human capabilities. Huhns and Singh (1997, p. 12-18 and p. 311-514) concluded that different types of agency models appear to be rational, social, adaptive, and communicative.

1. Rational Agency: Logical and Economic. Logical rationality includes logical, typically qualitative concepts, such as consistency of beliefs or the suitability of actions given beliefs and intentions. Economic approaches assume that the agent's preferences are given along

with knowledge of the effects of the agent's actions. From these, the rational action is the one that maximizes preferences.

2. Social Agency. Social agency involves abstractions from sociology and organization theory to model societies of agents. Sociability is essential to cooperation, which itself is essential for moving beyond the somewhat rigid client-server paradigm of today to a true peer-to-peer distributed and flexible paradigm that modern applications call for and where agent technology finds its greatest payoffs (Hunn and Singh, 1997).
3. Interactive Agency. Interactions occur when agents exist and act in close proximity. Interactions can be of various kinds but can be classified into two main categories: intended or otherwise. Intended interactions are primarily communications; they may occur through share resources, which can then be viewed as a kind of shared memory. An example of unintended interactions is resource contention; for example, when an agent accidentally bumps into another or inadvertently deletes files to which another agent needs access. Typically, for such communication to take place, some shared conventions must be in place based on communication language.
4. Adaptive Agency. One of the important properties of agents, and one that lay users expect, is that agents are adaptive. This typically presupposes that the agents are persistent and can learn. Much of the learning that the user encounters with agents has to do with learning values for some parameters, for example, to personalize a user interface by modeling the user. This and some other work essentially apply ideas from traditional machine learning to agents. The challenge is to cast agent learning of existing approaches. For example, learning from an environment is appropriate for agents that behave autonomously to some extent (Hunn and Singh, 1997).

A Listing of Intelligent Agents Research

There have been a number of studies done on using intelligent agents to assist human action.

O'Leary, Kuokka, and Plant (1997) reported their investigation on the impact of AI to virtual organizations. Their study explicitly showed that intelligent agents were the dominant AI devices in virtual organizations, proving to be a paradigm apparently suited to multiple, heterogeneous database structures. They investigated various types of virtual organizations ranging from virtual laboratories and organizations, to virtual classrooms and virtual environments for training. In the virtual classrooms and virtual environments for training, they reported that the intelligent agents have been used to facilitate training that allows students to learn on their own and to guide them through the learning process. Agents played a critical role in each of these virtual classroom environments. Agents limited the need for students to be present at some central location. Instead, agents facilitate off-site intelligent tutoring. Agents allowed student experimentation with Web-available resources. Other projects that were included in this investigation were implemented in a World Wide Web infrastructure using intelligent agents to facilitate communication among organizational participants. However, the authors left some closing remarks that companies studied in their investigation had competitive reasons for not disclosing what worked and what didn't.

Selker (1994) reported on Cognitive Adaptive Computer Help (COACH), a system that recorded user experience to create personalized user help. COACH was an advisory system that did not interfere with the user's actions but commented opportunistically to help the user along. COACH was designed to demonstrate the use of adaptive automated help and watched user's actions to build an adaptive user model that selected appropriate advice. COACH might choose to use description, example, syntax, timing, topic style and level of help according to user-demonstrated experience and proficiency. A description that advertised a command or function was helpful for getting started but might become ignored if it was presented too often. Example information demonstrating how to perform a procedure was often valuable until the procedure was mastered. Syntax information generalizing the procedure became valuable when the procedure was more or less mastered.

His study showed that an adaptive advisory agent could significantly increase user comfort and productivity. The COACH system demonstrated that agent technology could successfully work in place of a human coach to give personalized instruction while a student was actually working out solutions.

Doyle and Hayes-Roth (1998) suggested that agents must be able to explore such varied worlds such as a human can. To do this, just as the real world, they must be able to sense and interpret the environment intelligently. However, he also proposed that if the environments were too sophisticated than the reasoning ability of the agents, then the agents must have help from the environment. His motivation behind the research was the intention to design a virtual environment that would support the activities of intelligent agents by embedding abstract knowledge in the environment with which such agents could reason. They provided a base that allowed agents to become instant experts on the content of the world and to retain that expertise as the world changes around them.

Etzioni and Weld (1994) reported their research on the Internet Softbot, a term derived from "software robot". The Softbot was a fully implemented AI agent developed at the University of Washington. The Internet Softbot was a prototype of a high level assistant, analogous to a hotel concierge. In contrast to systems for assisted browsing or information retrieval, the Softbot accepted high-level user goals and dynamically synthesized the appropriate sequence of Internet commands to satisfy those goals. The Softbot executed the sequence, gathering information to aid future decisions, recovering from errors, and retrying commands if necessary. The following were examples of the types of requests that the Softbot handled:

- Notification requests: The Softbot can monitor a variety of events -- disk utilization, user activity, bulletin boards, remote FTP (file transfer protocol) sites -- and communicate its findings to the user in a beep, an on-screen message, an email message, or printer output. The Softbot determines autonomously how to monitor events as well as how to notify the user of its findings.
- Enforcing constraints: In addition to filling information-gathering requests, the Softbot can act on the world around it. For example, a user can ask it to ensure that all files in a shared directory are group-readable or that the contents of an archival directory are compressed.
- Locating and manipulating objects: The Softbot can compile source code, convert documents from one format to another, and access remote databases. Users find the Softbot very convenient to use because it can communicate using partial descriptions of people, objects, and information sources and automatically execute commands until it has disambiguated the request.

The Internet Softbot was an excellent example of a goal-oriented agent. Goal-orientation is useful only if users find specifying requests easier than carrying out the activities themselves. The agent must specify three criteria to make goal specification convenient for users: expressive goal language, convenient syntax, and mixed-initiative refinement dialogue.

The Softbot had many, but not all, of the desirable properties of intelligent agents discussed earlier, such as autonomous, goal-directed, flexible and self-starting. However, the Softbot was not mobile because it compromised its ability to keep user goals and preferences confidential.

Lieberman (1997) described his research on Letizia as an autonomous interface agent that treated searches through the Web space as a continuous, cooperative venture between the user and a computer search agent. Letizia recorded the URLs chosen by the user's interests. A simple keyword-frequency information retrieval measure was used to analyze pages. Letizia was always active, searching the web space that was near the user's current position, in parallel with the user's browsing activity. Letizia then used Netscape's own interface to present its results, using an independent window in which the agent browsed pages thought likely to interest the user. In autonomous agents like Letizia, the view of the web browsing as query-based information retrieval was replaced by a view of Web browsing as a real-time activity. The goal was to not to retrieve the "best answer" in any absolute sense, but rather to make the best use of the most limited and valuable resource -- the attention of the user.

Letizia based recommendations on the page the user was examining at the moment; the user often saw both an explicitly selected page and an agent-recommended page simultaneously. The flow of thought of the user's browsing activity was not interrupted by the need to switch to an independent query interface. The agent recommendations came "just-in-time" as the related pages arose in the user's browsing activity (Lieberman, 1997). Letizia's search process was based on an observation about the control structure of browsers such as Netscape. The basic structure of a browser is to display a set of choices, the links to other web pages, along with the page text and pictures. The user then picked one of the links, leading to another web page, again with links, text and pictures. Picking one of the links again led to another page, and so on. Each time, the user generally moved down in the web hierarchy.

Lieberman (1997) concluded that autonomous interface agents worked best in situations where their decisions were not critical. He described that many people were afraid of granting autonomy to interface agents because of the fear that the agent will make a bad decision without their consent. However, there are many instances that the decisions are not critical and the agent can be cast in the role of making suggestions rather than having responsibility for solving the whole problem. In these situations, the agent does not have to make the absolute best choice in order to be useful, but only offers a suggestion that was better than nothing, or a good enough guess (Lieberman, 1997). In addition, agent defaults can either be knowledge-based dependent on an agent predefined knowledge and inference of the probable goals of the user, as in Etzioni's Internet Softbot, or behavior-base predicted from empirical observation of the user's behavior, as in Letizia. Combinations of both approaches are also possible (Lieberman, 1997).

Rhodes and Starner (1996) presented in their study on the Remembrance Agent that it was an autonomous interface agent, one that reminded the user of relevant files stored on the user's local disk. It remembered the past showing the user relevant material that they had already seen, whereas Letizia remembered the future showing material not yet seen.

Interface Agents

Lieberman (1997) gave an interesting notion of an interface agent stating that an interface agent is a program that can also affect the objects in a direct manipulation interface, but without explicit instruction from the user. The interface agent reads input that the user presents to the interface, and it can take changes to the objects the user sees on the screen, though not necessarily one-to-one with user actions. The agent may observe user inputs, over a long period of time, before deciding to take a single action, or a single user input may launch a series of actions on the part of the agent, again, possibly over an extended period of time.

Etzioni and Weld (1994) defined the term interface agent as a “robot” whose sensors and effectors are the input and output capabilities of the interface, and due to these capabilities interface agents are also sometimes referred to as “softbots”. Selker (1994) described that the best-known examples of interface agents are intelligent tutoring systems and context-sensitive help systems.

Autonomous Agents

Lieberman (1997) described an autonomous agent as an agent program that operates in parallel with the user. Conceptually, autonomy of an agent indicates the property of the autonomous agent as always running. The agent may discover a condition that might interest the user and independently decide to notify him or her. The agent may remain active based on previous input long after the user has issued other commands or has even turned the computer off (Lieberman, 1997).

Franklin and Graesser (1996) described the term autonomous agent as a system that situates within and as part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future. On the needs of the autonomous agents, they described that an assistant may not be of much practical help if the user needs very explicit instruction all the time and constant supervision while carrying out actions. Assistants can be time-savers when they are allowed to act independently and concurrently. Allowing an interface agent to run off-line and in parallel with the user directing attention to other activities, enables the user to truly delegate tasks to the agent.

The interface type of autonomous agents is considered to be conversational. The user performs input, enters it, the system accepts the input, computes some action, displays the result, and waits for the next input. This has the property of the system doing nothing while the user is preparing the input, and the user is doing nothing in the interface, except maybe typing ahead, while the system is running. The user must explicitly initiate every action of the system (Franklin and Graesser, 1996).

Autonomous Interface agents

Lieberman (1997) stated that an agent may exhibit each of these characteristics independently: (a) An interface agent may observe user interface actions and make changes to user interface objects displayed on the screen without having the capability to continue running in parallel with the user, or (b) an agent may have the capability to run autonomously without needing to interact through graphical interface operations, except in a trivial sense in which displaying any text to the user is part of a user interface. For example, many programs send an email to the user when there is an update to Web pages the user has marked as interesting; these agents are autonomous, but operate outside the user interface.

In order for an agent to be considered both an interface agent and autonomous, it must be some part of the interface that the agent must operate in an autonomous fashion. The user must be able to directly observe autonomous actions of the agent and the agent must be able to observe actions taken autonomously by the user in the interface. Consequently, the user will see interface elements that appear to move by themselves in response to input that the agent appeared to see for itself rather than its having been explicitly instructed (Lieberman, 1997).

User-Interface Agents

Dryer (1997) expressed the term user interface agent for new intelligent user interface technologies that could help prevent people from making mistakes by guiding them through information system tasks. To be effective, user interface agents must be applied to tasks that exploit the potentials of the user interface agent without expecting them to perform beyond their constraints. Intelligent user interfaces apply artificial intelligence (AI) to the problems of human machine interactions. As user interfaces become more intelligent, they offer people more assistance with their information system tasks. User interface agents are an important piece of the intelligent assistance. (Dryer, 1997)

Atkinson, Brady, and Gilbert (1995) stated that the most common user interface agents are called “wizards”. These user interface agents provide task assistance by breaking the task into a (typically) linear series of steps and presenting the steps to a person one at a time (Atkinson et al., 1995). Because wizards work best with a linear series of steps, they are most successful when the tasks have algorithmically derived solutions (Atkinson et al., 1995). These user interface agents generally do not use any artificial intelligence. People may perceive them as "intelligent" because they are task specific (Wilson, 1995). A well-designed wizard replaces a multi-purpose task interface with a task specific interface to guide a person along an efficient path to success, autonomously completing those steps of the task that do not require a person's intention.

Atkinson et al. (1995) described their research on Guides, which were defined as another kind of user interface agents. Typically Guides provide task assistance by monitoring a person's interaction with the information system and presenting information appropriately. In particular, a Guide could annotate a graphical user interface (GUI) in a manner that communicates how to perform the next step in a task and draw a person's attention to where the next step will occur (Atkinson et al., 1995). Guides are intelligent because they annotate an interface whenever and however it most likely to be useful. A well-designed guide will direct a person through the next step in a task.

Review of Literature on Intelligent Tutoring Systems

Concepts in Intelligent Tutoring Systems

The field of Intelligent Tutoring System (ITS) is almost three decades old but only a handful of ITSs built so far have made their way into real educational environments (Khuwaja, Desmarai, and Cheng, 1998). The ITS community is beginning to be aware of this concern and a number of researchers have already started to suggest different ways to remedy this situation. The field of ITS has great promise and potential to be effective in both educational and training worlds but these two worlds have their own unique demands and requirements (Khuwaja, Desmarai, and Cheng, 1998). Only cost-effective computer-based systems are capable of justifying their acceptance in real world situations.

ITSs are complex systems. A common trend in the ITS community is to organize the development of a tutoring system around four components: diagnostic, (domain) expert, pedagogy, and communication methods. In order for an ITS development methodology to be flexible and generic it needs to prescribe the development of each of these modules. The nature of these modules depends upon the consideration for the overall architecture for an ITS. Wenger (1987) has characterized ITSs as consisting of either model-based or curriculum-based architectures. A model-based ITS emphasizes the model view of the domain expertise. Some example ITSs in this class are Lisp Tutor (Anderson, Boyle, et al., 1990), QUEST (White and Frederiksen, 1990), and CIRCSIM-Tutor (Kuwaja, 1994). The curriculum-based ITSs, on the other hand, emphasize the curriculum view of the domain expertise, example ITSs in this class are: BIP (Barr, Beard, and Alkinson, 1976), WUSOR (Goldstein, 1982), and MWH (Lesgold, 1988). According to Wenger (1987), a curriculum-based architectures "emphasizes the notion of lesson rather than that of model as a reservoir of domain knowledge" (p. 149).

The necessary updating of professional skills, the existing dissatisfaction with many educational systems and the aspiration for personal development call for more individualized education and training (Grandbastien, 1998). Network and Web technologies are now available to provide education and training nearly everywhere at any time. Teacher knowledge is now the core problem for the design of the needed environments, thus it is crucial to make teacher knowledge more explicit for improving the performances and flexibility of computer-based learning environments (Grandbastien, 1998).

A Listing of Intelligent Tutoring Systems Research

There have been numerous approaches in the field of AI and education aimed at providing peer help for the learner. Most of them, however, try to create an artificial peer, i.e. an intelligent component or agent, who collaborates with the learner, an approach that was originally proposed by Self in 1986 (Self, 1986). Examples of such artificial peers are Dillenbourg & Self's (Dillenbourg and Self, 1992) artificial co-learners, Chan & Baskin's learning companions (Chan and Baskin, 1990), and Aimeur & Frasson's "troublemaker" (Aimeur and Frasson, 1996). All of these systems are focused on collaborative problem solving (and consequently have a very restricted domain of application). They generated help and utterances themselves (using knowledge bases) and decided when to interfere (using their pedagogical strategies). In this sense they were classical Intelligent Tutoring Systems (ITS).

The Intelligent Helpdesk developed for the ARIES lab at the University of Saskatchewan in Saskatoon, Canada (Greer and McCalla, 1998) also used artificial intelligent techniques to provide automated help to students upon the requests of the learner. Greer and McCalla (1998) described approach to provide peer help differed significantly from other classical approaches. First, the subject domain of the Help-Desk could be as broad as needed; the only requirement was the existence of some kind of domain structuring (into topics, concepts, tasks and skills) to which help-requests could be indexed. Second, there was minimal fully autonomic generation of computer-based help, so the system could perform a less extensive knowledge base and less sophisticated reasoning mechanisms.

Tecuci and Keeling (1998) described the disciple approach of Intelligent Educational Agents as an apprenticeship, a multi-strategy learning approach for developing intelligent agents where an expert taught the agent how to perform domain-specific tasks in a way that resembled how the expert would teach an apprentice.

Mengelle, De Lean, and Frasson (1998) defined Actors as a reactive, instructible, adaptive and cognitive agent, which exhibited two main properties: It reacted to the activity of others and was able to learn. The first property stemmed from the combination of three approaches: reactive agents, deliberative agents and interacting agents (Mengelle, De Lean, and Frasson, 1998). Actors was a research project that used intelligent agents inside the Intelligent Tutoring Systems (ITS). A new kind of agent (actor) was designed to model the pedagogical expertise of ITS. Actors aimed to help a student to learn using powerful cooperative pedagogical strategies. Actors had some learning abilities to improve the knowledge acquisition process and to foster revision of expertise. Improving the expertise of an actor required two distinct tasks: diagnosis of a problem, then revision of the actor's expertise in order to solve it. The diagnosis stage checked that the behavior of the actor respected its goals. Each actor considered two distinct global goals and the collective goal of the society. In most cases, these goals could be divided into several sub-goals. The aim of the diagnosis stage was to check every sub-goal and to identify the possible problems. Once a sub-goal failure was detected, the revision stage aimed to modify the expertise of the actor in order to improve its future behavior. The actor paradigm allowed intelligent tutoring systems to foster learning using various powerful cooperative strategies such as learning by disturbing. Actors can manage complex, domain-related and powerful resources (Mengelle, De Lean, and Frasson, 1998).

Khuwaja, Desmarai, and Cheng (1998) described Intelligent Guide as a computer-based educational system under development at the Computer Research Institute of Montreal (CRIM). The goal of Intelligent Guide was to develop a generic Intelligent Tutoring System (ITS) that could provide user knowledge assessment and pedagogy guidance for a number of domains that required the user to master a number of concepts or skills for achieve a satisfactory level of competence in the domain. Intelligent Guide had a generic curriculum-based architecture. It was designed to operate with a general knowledge assessment method. This method uses a kind of overlay type user model. The typical knowledge domains for the Intelligent Guide consisted of a large body of concepts and skills that a student needed to master. Leaning of concepts and skills could be tested by asking one or more questions to the student. All the concepts and skills could be arranged in a network of nodes that were connected by several relationships such as part of, analogy, or co-topic. In other words, knowledge in Intelligent Guide domains could be presented by a type of curriculum.

Intelligent Guide was like a tutoring assistant that assessed the knowledge state of the student for a domain. Based upon this assessment, it pointed out areas in the knowledge domains that required attention from the user. The degree of attention required by the user for these areas was part of the feedback provided by Intelligent Guide. Further, depending upon the user's choice, this tutoring assistance could invoke a tutorial lesson for a domain concept/skill that needed to be learned/mastered by the user. In addition, Intelligent Guide was not designed to provide a full delivery of contents for each domain topic but rather a brief but comprehensive overview of major concepts required. It was assumed that the users knew the basics of knowledge domains. These users were mainly looking for assessment of their knowledge level and individualized (active) reviews of the different domains. The system provided pointers to commonly available books and other form of resources for the user to acquire advanced knowledge of the domain.

The ultimate goal of Intelligent Guide was to encourage the user to periodically use the system while participating in a preparatory course or preparing for a test like the GMAT. In this way, the user would have the opportunity to keep track of his or her progress in learning the new domain material. Considering this goal of the system, it was imperative to continuously evaluate the knowledge state of the student to individualize feedback and guidance.

One of the fundamental components of the Intelligent Guide was the user knowledge assessment module. This module was responsible for providing a user profile of the knowledge network's state of mastery. Based upon the information it received from the pedagogy engine about what knowledge unit (KU) was mastered by the user, the knowledge assessment module inferred the likelihood that every other KU is mastered.

The knowledge assessment module of the Intelligent Guide adopted the overlay approach to defining the whole domain knowledge. It used a view of the knowledge network that organized fine-grained Knowledge Unit (KU), or nodes, into a knowledge structure that represented the order in which the KU were learned. An individual's knowledge about the domain, i.e. knowledge state, was modeled by a collection of numerical attribute values attached to the nodes. Each value indicated the likelihood (i.e., probability) of a user's knowing a specific KU. In the knowledge structure, KU were connected by implication (precedence) relations. An implication was, in fact, a graduation constraint which expressed whether a certain concept had to be understood before another difficult one, or whether a certain skill was acquired prior to an advanced one. It was these implication relations that enabled the inferences about mastery of KU (Khuwaja et al., 1998).

Brusilovsky, Schwawz, and Weber (1996) described ELM-ART as an ITS on the World Wide Web. This system taught Lisp programming by providing an intelligent interactive integrated textbook. The examples given to the student were those that were most relevant during problem solving. Furthermore, when a page was displayed that included a problem, links to the course material were included corresponding with that problem. The tutor also suggested the material most appropriate for the student. But if the student attempted material for which he was not quite ready, the tutor would provide prerequisite links for him to explore, if he so chose. However, the system was only text-based and the student model was a rather shallow overlay model.

ELM-ART dynamically generated all the HTML pages based on the student model and the stored domain knowledge. The tutor provided feedback when a student was trying to solve a problem, and adapted the curriculum to the student's abilities. When presenting links to the student, indicating pages in the material to examine, ELM-ART suggested those pages for which a student was ready. In this way, the student could either take the suggestions of the tutor or explore in his own direction. ELM-ART successfully allowed students to progress through the material as they chose, but provided sufficient suggestions so they had good guidance.

This chapter investigated research in two main areas -- Intelligent Agents and Intelligent Tutoring Systems -- which are closely related to the topic of the current study. Despite there is no specific study found done in the area of ALN or on-line learning, and no specific measure found that can be adapted to the current research, this is understandable because the topic is quite new. The review of literature in this chapter has contributed a strong foundation to understanding roles and characteristics of the intelligent agents and intelligent tutoring systems in the ways that they provide assistance in learning, coaching, and tutoring activities. I believe that this study can provide the knowledge needed to further develop and improve the intelligent agents for on-line learning.

CHAPTER III

METHOD

In this section, research approach, study design, criteria of evaluations, and measurements will be described.

Research Approach

This is an exploratory study. The analysis was performed based on the matrices of measurement to investigate whether the use of KnowBots affected learner retention rate in the workshop. Data for analysis were obtained from two distinct groups of the ALN Workshop: one group completed the workshop with help from the KnowBots and the other group without help from the KnowBots.

Evaluations performed in this study were both formative and summative. In the formative evaluation, KnowBots development is described in the Design and Implementation chapter of this dissertation. In the summative evaluation, the results from both on-line workshop sessions, with and without the help from KnowBots were tested. Data acquired from the experiment were analyzed to test the hypotheses. The dependent variable of the study was the percentage of completion between the two groups compared by assignment. The study examined the possible effects of the independent variable, the use of KnowBots, to the dependent variable, the completion rates of the workshop. In addition, the study also attempted to examine the effects of other intervening variables that might be a factor to the completion rates of the workshop. These intervening variables were user access, user satisfaction, facilitation time, and motivation.

Sample

The experimental population of interest is participants who took the ALN workshop between the session of May-98 and January-99. We chose all participants from May-98 session of the workshop as the control group, which means that they completed the workshop without receiving help from KnowBots. All participants from September-98 and January-99 sessions of the workshop were selected as the treated groups of the study. Although both September-98 and January-99 sessions were the treatment group, each session was observed separately since we suspected that KnowBots of these two sessions might show some differences in the completion rates due to KnowBots maturity.

Hence, the total numbers of 220 participants in May-98 session of the workshop were used as a control group. Ninety eight participants in September-98 and 64 participants in January-99 sessions were used as the experimental groups.

Study participants from all three sessions came from the following disciplines: 42% working in the area of education, 11% in medicine and nursing, 10% in community colleges, and 7% in training. The remaining 30% were in engineering, administration, art, government, or trade.

While the study sample might not be considered a fair selection of treatment on the population, generalizability was not a primary goal at this attempt -- the major purpose of the study was to determine whether the use of KnowBots affected the retention in the program. Any effects of the use of KnowBots may be generalized to on-line courses that are conducted in similar ways.

Completion rate was one of the measures used in this study, and is one of the most commonly measures used to determine the effectiveness of any classroom course. All other measures were used to determine other possible effects of the use of KnowBots such as facilitation time, learner satisfaction, and motivation to the completion rates. Data for analyses were obtained from database analysis of the KnowBots system, the conferencing system, log files, and from the structured survey questionnaire.

<u>Completion rate</u>

Percentage of completion of each session of the workshop compared by assignments and by the overall workshop was used as the prime measure and as the dependent variable of the study to determine the effects of the use of KnowBots on the ALN workshop. The completion numbers from each group were obtained from the databases maintained by the KnowBots system. Significant differences between the completion number percentages of each session were studied to examine the effect of the use of KnowBots on the workshop.

Number of uses of the KnowBots system

The number of times the participants used the KnowBots system in September-98 and January-99 session of the workshop was used to measure another effect of the KnowBots system on the completion rate. A correlation analysis was performed to investigate whether more frequent use of the KnowBots system by participants resulted in a higher assignment completion. Data in this category were obtained from the log file of the KnowBots' database.

Number of visits to the learning material by participants

The number of visits to the learning material by the participants was used to investigate whether the use of KnowBots improved access to the learning material. A correlation analysis was performed against the completion rates and the number of times participants use the KnowBots to determine the association between variables. The three-variable-matrix of the correlation test helped provide evidence to support the effects of KnowBots on completion. These data were obtained from the log analyses of the server hosting the learning materials of the workshop.

Facilitation messages posted by the facilitators

The average number of messages posted in the conferencing system by facilitators was used to determine total and average facilitation time that the facilitators spent facilitating on each workshop session. Facilitation time was estimated based on complexity of the message. Additionally, these data were examined against the number of participants and the number of completions of each session of the workshop before and after the KnowBots system was used. These data were used to determine whether the use of KnowBots reduced the facilitation time. Data were obtained from the analyses of the conferencing database of each session of the workshop.

Number of messages posted by the participants

Data in this category were used to investigate how the average number of messages posted by participants in the conferencing system between groups associated with the number of completion and the use of KnowBots. These data were obtained from the analyses of the conferencing system database.

In addition to the data obtained from the post-workshop databases above, data listed below were obtained through the use of the survey questionnaire (See Appendix E). A comprehensive analysis of these data led to a better understanding of the effects of KnowBots on completion and on other factors, such as motivation, confidence, learning behavior, user satisfaction, etc. Ratings are given on a 1-to-5 Likert-type-response scale where 1="very low, very poor, or not at all" and 5="very high or excellent".

Usability rating by participants

Participants who experienced using the KnowBots system were asked (Question #4.9 - 4.11) to rate the helpfulness of the features of the KnowBots. The features are "email notification/reminder", "on-demand checkers", and "report and direction".

Motivation

Participants were asked to rate how the KnowBots helped motivated them to complete the workshop (Question #4.2). In addition, an open-ended question was also provided to the participants encouraging them to freely add their opinions (Question #4.17). Additional questions asking the participants about the motivational effects of each feature were also provided (Question #4.14 - #4.16). These data were used to analyze how the use of the KnowBots system affected the motivation of the participant to complete the workshop.

Effectiveness of instruction

Participants were asked to rate whether the instructions given by the KnowBots were effective (Question #4.4).

Confidence

Participants were asked to rate how the use of the KnowBots improved their confidence to complete the workshop (Question #4.6).

Consistency with the instruction

Participants were asked to rate how consistent the KnowBots' instructions were with the instruction (Question #4.5).

User's satisfaction

Participants were asked to rate how well the KnowBots helped the participant to complete the assignments (Question #4.7).

Learning Behavior

Participants from both treated groups were asked in an open-ended question how the KnowBots changed the way they learn (Question #4.8).

User-Interface

Participants were asked in an open-ended question in what way the KnowBots helped the participant to complete the assignment and the workshop (Question #4.19).

Time to learn

Participants were asked to rate whether the KnowBots helped reduce time to learn the learning material (Question #4.8).

Access

Participants were asked to rate whether the KnowBots helped improve access to the on-line material (Question #4.3).

Study Design and Procedures

The study consisted of two groups taking the same course; Getting Started Creating On-line Courses, which covered fundamental conferencing systems, HTML, basic and advanced FrontPage, and advanced media for on-line development and support. All participants were required to complete the same eight assignments using the same procedures in the approximately eight-week period.

Primarily, the completion of each assignment of the ALN workshop was criteria based. This means that the completion of each assignment was determined to be either pass or fail based on pre-specified criteria.

The difference between groups was the help given from KnowBots during the course of study: one group received help from the KnowBots and the other group did not.

The control group, or the 'conventional' participant group from the May-98 session of the ALN workshop, received help through the standard procedure of communicating with the workshop facilitators through the use of the conferencing system. A workshop facilitator was engaged to respond to questions or assignments submitted. In this session, the facilitators solely determined the status of completion of each assignment.

In addition to receiving the conventional help from the facilitator through the use of the conferencing system, the treatment groups of the study, which were the participants from September-98 and January-99 session of the ALN workshop, received help from KnowBots. There were two types of KnowBots created for these groups: scheduled and on-demand. The scheduled KnowBots performed assignment-checking tasks on the very specific dates such as on two days before the due date, on the due date, two days before the requirement for certification ends, and on the date the requirements are due. After checking the participants on the scheduled dates, the scheduled KnowBots autonomously composed an email to report the checking results to the participants. The email message included explicit suggestions and directions of how to fix the problems. Another implication of the automated message was to encourage the participant to finish the assignment. Helpful hyperlinks were included within the message -- a link to where to communicate with a (human) facilitator on a very specific problem, a link to where to find the relevant material, instruction, or the requirement for certification, and a link to where the participant could give suggestions and feedback about the system, etc.

The on-demand KnowBots allowed the participants to check their assignments at any time they wanted to. The functionality of the on-demand KnowBots was quite similar to the scheduled ones except that the individual user invoked them.

The KnowBots system was capable of recording in the knowledge base all activities and interactions between all parties: participants, KnowBots, and facilitators. Hence, these data were used to support the measures of the effectiveness of the KnowBots. Other than the completion rates of all three sessions, data such as amount of time using the KnowBots, number of messages posted in the conferencing system, number of visits to the learning material, etc. were analyzed to provide evidence to support the investigation of the effect of KnowBots.

This type of experimental design might not be strong against some threats to the validity of the study. Its primary weaknesses are in the potential for selection and maturation threats and for problems that may result from the varying Internet-related knowledge between the two groups. There is a possibility that there were some deleterious effects due to participant knowledge of Internet-related exercises (e.g., FTP, and web authoring) being higher in the later sessions. It is not plausible that facilitators might have equalized conditions between the two groups. Due to the limited time frame of this research, to make this study plausible we assumed that there was no difference in participant knowledge between the groups. Again, our primary interest of the study was to investigate possible effects of adopting this type of technology to on-line learning environments like the ALN workshop.

CHAPTER IV

DESIGN AND IMPLEMENTATION

In this chapter, current system architecture, design and implementation approach of KnowBots will be described:

Current System Architecture and Implementation

KnowBots are computer programs that employ intelligent agent techniques. KnowBots for ALN workshop have been created to help reduce the time and costs required to facilitate the workshop, and to help the participants to learn the workshop material more effectively.

Implementation and Functionality of KnowBots

The approach of creating KnowBots has been from the bottom up. It began with defining possible useful and feasible tasks for a software agent. The first such task involved the activities surrounding the assignment-checking task of the ALN Workshop. A set of software was designed and implemented to handle this task. This job was quite routine, but consumed a substantial amount of the facilitator's time. The normal sequence of tasks consisted of reminding participants about upcoming due dates of the assignments, checking submitted assignments, collecting requests, responses and feedback from participants, encouraging participants to complete the assignments, and giving the participants the results of the assignments.
Two types of KnowBots were created for the Workshop: scheduled and on-demand.

<u>Scheduled KnowBots:</u>

The scheduled KnowBots perform the assignment checking of each participants' assignment of each participant autonomously on specific dates, such as on two days before the due date, on the due date, etc., and sends a notification or a reminder email to the participant. The scheduler of each assignment KnowBot, which has been previously determined, controls the running schedule of the KnowBot. By communicating with the Knowledge base, the KnowBots can intelligently learn about the user (participant), and about the requirements to complete the specific assignment.

<u>On-demand KnowBots:</u>

A workshop participant can invoke the KnowBots to check his or her assignment at anytime he or she wants. The on-demand KnowBots is invoked by the request's request through the World Wide Web. The on-demand KnowBots perform a check of a particular assignment for the user.

Current System Architecture

There are five basic components of the current system:

- KnowBots
- User
- Knowledge base
- Assignment repository
- Facilitator

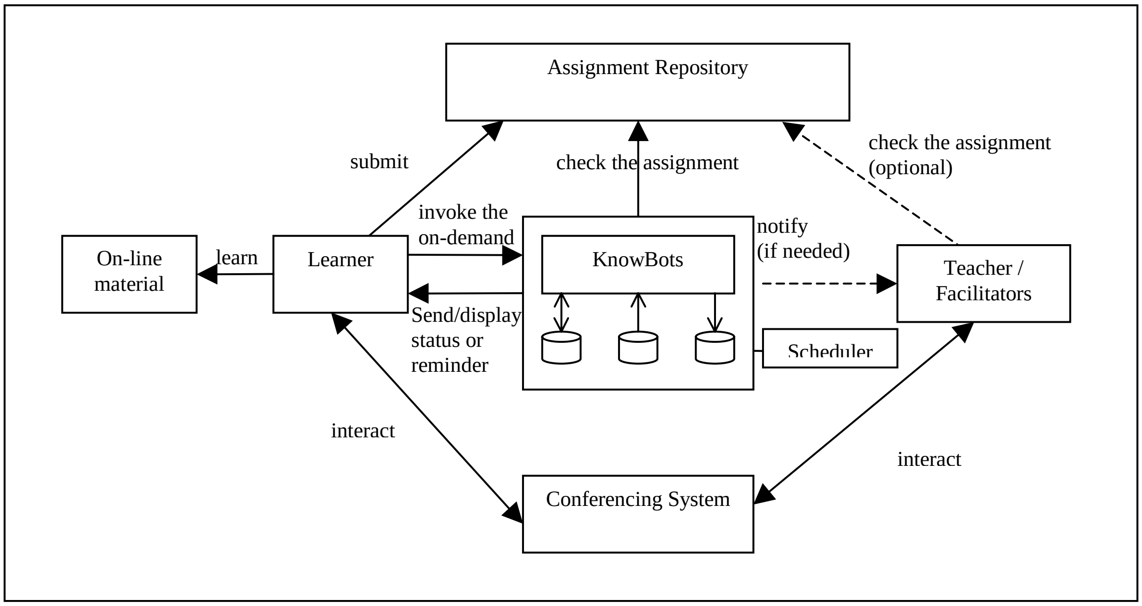


Figure 1. System's General Architecture

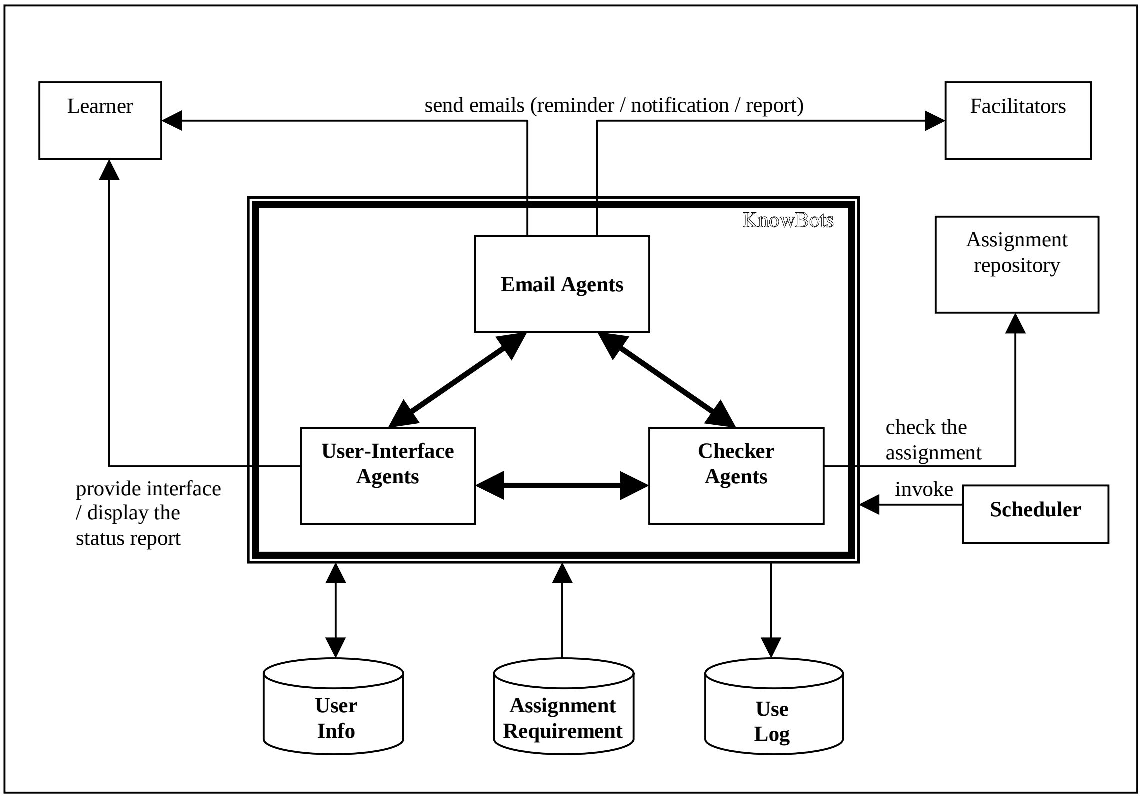


Figure 2. Internal Architecture of KnowBots

KnowBots

The KnowBots architecture has been created based on knowledge-based agents -- which are dependent on an agent's predefined knowledge. KnowBots consist of user-interface agents, checker agents, email agents and knowledge base modules:

1. User-interface agents are graphical interface, web-based agents. A user commences interaction with KnowBots through the use of these agents. The user-interface agents provide a user-friendly interface to the user and act as a communication medium between the user and KnowBots. Primarily, the functionality of the user-interface agents are to:
    - execute the checker agents by request
    - present information to the user
    - provide appropriate interfaces to execute actions such as requests for help
    - incorporate other relevant resources for the user

- communicate with other agents (checker agent and email agent) and with the knowledge base (e.g., tracks the interactions between users and system).

2. Email agents are responsible for generating, composing, organizing, and sending emails to both the facilitators and the participants. Examples of emails that are generated and sent to the participants are the assignment-status report, assignment reminder and notification, and message responding to request for help. The email agents compose the content of the email by retrieving data from the knowledge base associated with other relevant information to assist the user in formulating queries. The email agents communicate with other agents and the knowledge base by using Cold Fusion Markup Language (CFML). Agent communication will be explained in Agent Communication in the next section.
3. Checker agents are responsible for checking assignments for the participants. The agents can be invoked either by the scheduler or by the participant through the user-interface agents. The main functionality of the checker agents is to determine the completion status of the assignment based on the pre-defined knowledge of requirements for assignment completion. The checker agents record the results and access the knowledge base through the established Open Database Connectivity (ODBC) using CFML. Moreover, by checking each individual's assignment, the checker agent attempts to determine what particular knowledge each participant needs in order to complete the assignment. The agents elaborate the checking results as well as provide the reference as to where to find that knowledge.

User

A "user" is a participant registered to take the workshop. Each user is required to complete eight assignments on-line. The participant is specifically required to submit the assignment either to the assignment repository or to the conferencing system. Other than receiving the automated status report, reminder, and notification on schedule basis from the scheduled KnowBots, a user has an option to invoke the on-demand KnowBots to check on his or her assignment at any time he or she chooses. The user may also use the checking results from the KnowBots as a tutor to complete his assignment.

Knowledge Base

The knowledge base is a collection of databases that stores predefined knowledge about users, facilitators, assignment models (assignment requirements), help objects, and use logs. Agents communicate with the knowledge base in a number of ways, such as retrieving user information from the database, storing use log in the database, etc.

Assignment repository

The assignment repository is the location or the storage of the participants' assignments. Depending on the requirements to complete each assignment, the assignment repository of a participant for the ALN workshop could refer to either the assigned web space or the messages posted by the participant in the conferencing system, or both.

Facilitator

A facilitator refers to a person who helps facilitate the workshop. Whenever the user needs further help with regard to the result received from the checkers, the question or the request is submitted through the KnowBots system. The email agents generate a notification email to notify the facilitators about the new question in the system. The email message provides a hyperlink for the facilitator to follow in order to respond to the user's problem. The facilitator then uses the web page composed by the user-interface agents to respond. As soon as the response from the facilitator is submitted to the system, the email agents compose an email to be sent to the participant. All of these activities are recorded to the KnowBots' database or knowledge base. This is a way that KnowBots keep tracks of all interactions between parties: participant, KnowBots, and facilitator.

At this stage, an option for the user to be able to get help from a human facilitator is still crucial. This is because the dynamics of the learning environment of the workshop and the unbounded problems that users encounter. Another reason is the diversity of the background knowledge of the participants. Some participants may require help in a topic that is as simple as how to FTP a file to a server. Some may require help in a much more complex topic such as how to deal with firewall problems.

Agent Communication

Agents communicate among one another and with the knowledge base using Cold Fusion Markup Language (CFML). The Cold Fusion Markup Language (CFML) consists of a set of tags used in Cold Fusion, a web-database application, to interact with ODBC data sources, manipulate data, and display output. CFML provides all intelligent agents of the KnowBots a communication framework. For instance, the email agents can precisely generate an electronic mail sent to a particular person based on the information retrieved from the knowledge base. The use of CFML enables intelligent agents to communicate with one another by passing parameters and variables among themselves, and learn from the users by storing or retrieving information through the ODBC database connection.

Scheduler

Scheduler is a pre-determined schedule controller that activates the checker agents to be active in a timely manner. The scheduler of KnowBots employs a functionality of Cold Fusion called CF Scheduler -- which enables the facilitator to schedule any Cold Fusion application on the specific dates and time without human intervention. The scheduler is also capable of storing the results of the scheduled CF applications in various formats such as text, HTML, or a Cold Fusion file.

Summary of KnowBots and Their Functionality

Scheduled KnowBots

Table 3 Scheduled KnowBots and Their Functionality

KnowBots name	Alias	Functionality/tasks
Scheduled KnowBots for Assignment #1	Checker 1, Agent1	1. look for 2 types of messages posted in the specified forum of the conferencing system by participants: one is a self-introduction message, the other is a reply-to-another message. 2. send reminder and checking-result email to the participants
Scheduled KnowBots for Assignment #2	Checker 2, Agent2	1. look for at least 3 course-reviewed messages posted in 3 different threads by the participants 2. send reminder and checking results by email to the participants
Scheduled KnowBots for Assignment #3	Checker 3, Agent3	1. check the status of each participant's personal homepage to determine if it contains the required elements such as mail-to tag, bulleted list, etc.. 2. check if each participant posted a message in the conferencing system 3. send an email to the participant about the checking results.
Scheduled KnowBots for Assignment #4	Checker 4, Agent4	1. check the status of course homepage of the participants to determine if completion requirements are met 2. check if the participants post a message with link to their course homepage in the specified forum 3. send an email to report and remind the participant about the status of the assignment
Scheduled KnowBots for Assignment #5	Checker 5, Agent5	1. check the participant's personal homepage for advanced FrontPage features such as image map, a FrontPage theme, etc. 2. check if the participant posted a message in the specified forum with links in the conferencing system 3. send an email to remind and to report the checking results to the participants

On-demand KnowBots

Table 4 On-demand KnowBots and Their Functionality

KnowBots name	Alias	Functionality/tasks
On-demand KnowBots for Assignment #1	On-demand Checker 1	1. invoked by the user using his/her email address as an identifier 2. look for 2 types of messages posted into the specified forums of the conferencing system by individual 3. report the status through the web browser 4. send an additional email to the participant only if the status has been determined as complete (confirmation, congratulation email)
On-demand KnowBots for Assignment #2	On-demand Checker 2	1. invoked by the user using his/her email address as an identification 2. look for 3 different messages posted in three different threads (on-line course names) 3. report the result through the web page
On-demand KnowBots for Assignment #3	On-demand Checker 3	1. invoked by the user using his/her email address as an identification 2. check his/her personal homepage whether it contains the specified elements 3. present the result to the user through the web page
On-demand KnowBots for Assignment #4	On-demand Checker 4	1. invoked by individual using email address as an identification 2. check the participant's course homepage for the required elements 3. report the result through the web page
On-demand KnowBots for Assignment #5	On-demand Checker 5	1. invoke by individual participant using email address as an identification 2. check the participant's course web for advanced FrontPage features 3. present the checking results through the web page
KnowBots for Assignment #8	Checker 8	1. invoked by the individual 2. check if at least one message is posted into the specified forum in the conferencing system 3. present the checking result to the user

Other KnowBots

Table 5 Other KnowBots and Their Functionality

KnowBots name	Alias	Functionality/tasks
KnowBots for Assignment #6	Checker 6	1. each participant is required to submit all relevant information of their assignment through KnowBots 6 2. notify the workshop facilitator about the submission 3. provide checking template for the facilitators to check the participants' assignment 4. store the results into the database 5. send a notification email to report the result to the participant
KnowBots for Assignment #7	Checker 7	1. provide submission form for the participant (through the web) 2. notify the facilitator about the submission 3. provide the facilitator a template to perform the checking tasks 4. store the result into the database and send a notification email to the participant about the results

Implementation Details

In this section, detailed implementation of each KnowBots is described:

KnowBots for Assignment #1

The assignment #1 of the ALN Workshop requires the participant to post at least two types of messages in the specified forum of the conferencing system: One posting is to introduce the participant himself and it must explicitly be titled "Introducing" followed the name of the participant. The second posting is a reply to someone else's posting.

Decision algorithm and flow diagram of KnowBots for Assignment #1

On the specific dates, the scheduler invokes the scheduled KnowBots for Assignment #1 to check the assignment status of all workshop participants.

KnowBots for Assignment #1 first, one-by-one, retrieve information about each participant from the knowledge base and use the participant's email address as an identifier to identify a message posted by the participant. KnowBots assume that each participant has only one email address in the Workshop.

KnowBots for Assignment #1 then go through all the messages in the specified forum of the conferencing system's database and attempt to identify messages posted by the participant using the participant's email address as an identifier. By using the capability of Cold Fusion Markup Language to establish the connection with the database of the conferencing system, it enables the KnowBots to directly communicate with the conferencing system's database. Information about which forum of the conferencing system KnowBots is to look for is pre-identified in the knowledge base before the workshop begins. After finding a message with a matching email, KnowBots then attempt to identify the type of message by looking at the subject field of the message. If the word "Introducing" is found in the subject of the message, KnowBots identify it as the personal introduction message. Otherwise, KnowBots identify it as the reply message.

After identifying types of messages, KnowBots record the checking results into the database. To complete the task, KnowBots verify whether both types of messages have been found by communicating with the knowledge base. If there is only one type of message found, KnowBots continue the same procedures to find the other types of message until reaching the last message in the specified forum. After that, KnowBots determine the final status of the participant's Assignment #1 by comparing the finding results from data in the database. The email agents of the KnowBots compose an email to be sent to the participant to report the checking result. The email includes other details as well such as greetings, encouragement (if determined as incomplete), congratulations (if determined as complete), and other helpful hyperlinks (e.g., links to on-line material, requirements for completion, to request submission form, to suggestion form, etc. -- mostly presented when determined as incomplete). Meanwhile, KnowBots record all activities into the log file as well as into the knowledge base.

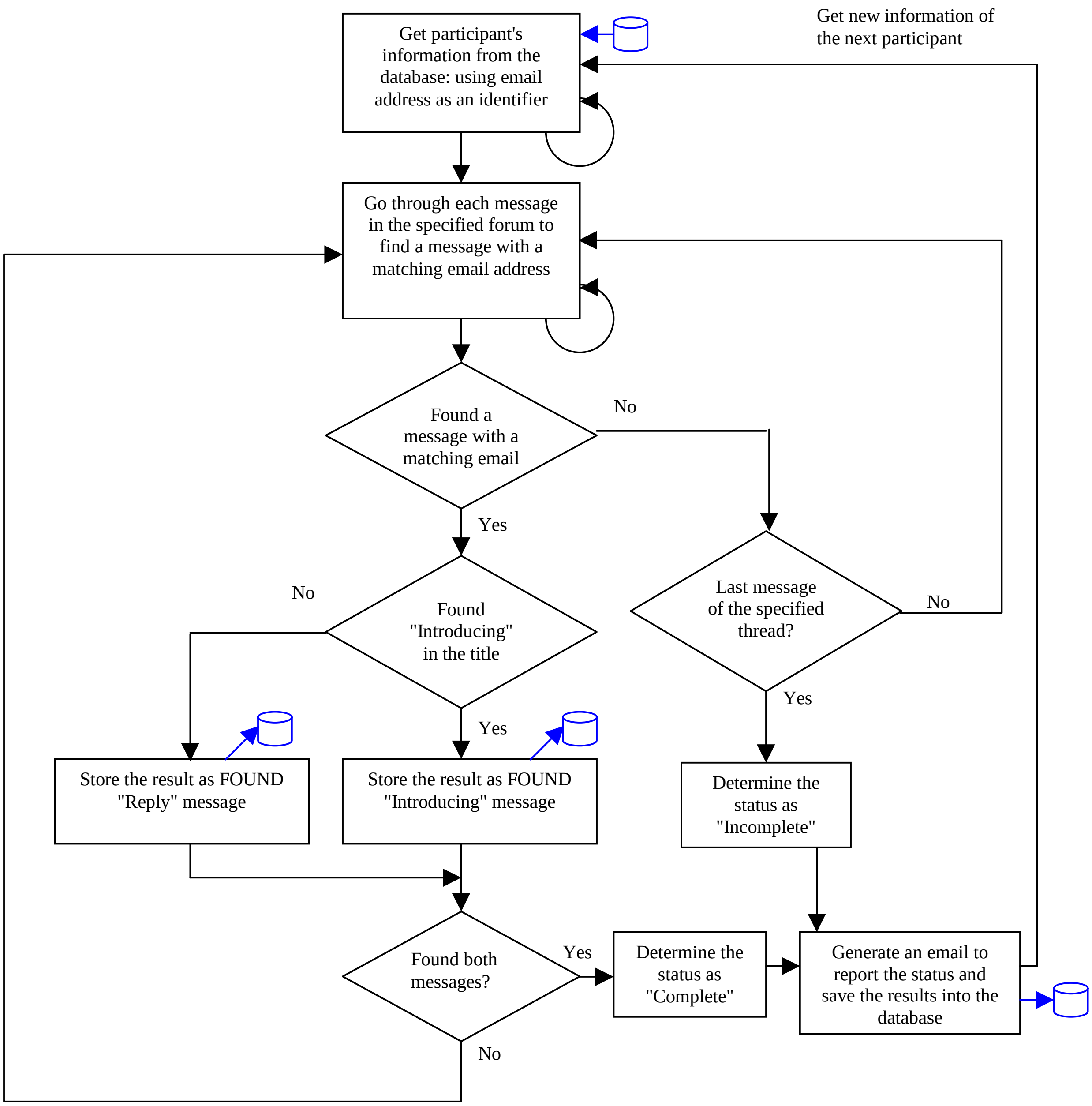


Figure 3. Decision Algorithm and Flow Diagram of Scheduled KnowBots for Assignment #1

X-Sender: alnweb@mailhost.vuse.vanderbilt.edu
X-Mailer: QUALCOMM Windows Eudora Pro Version 4.0
Date: Tue, 23 Feb 1999 17:16:20 -0600
To: choon@mailhost.vuse.vanderbilt.edu
From: ALN Web Group <alnweb@vuse.vanderbilt.edu>
Subject: Assignment #1 Reminder

Dear Choon,

Assignment #1 Reminder: It's two days before Assignment #1 is due, so
here's an
update on how you are progressing.

Congratulations. You have completed the assignment #1.

This is Checker 1, an automated email agent. Please do not send
email back to this address.

Please take a few moments to help me improve. To do so, please follow the
link
below and provide your comments and feedback about whether I am helpful.

http://workshops.aln.org/wsfaq/test/comment.cfm?Agent_ID=1

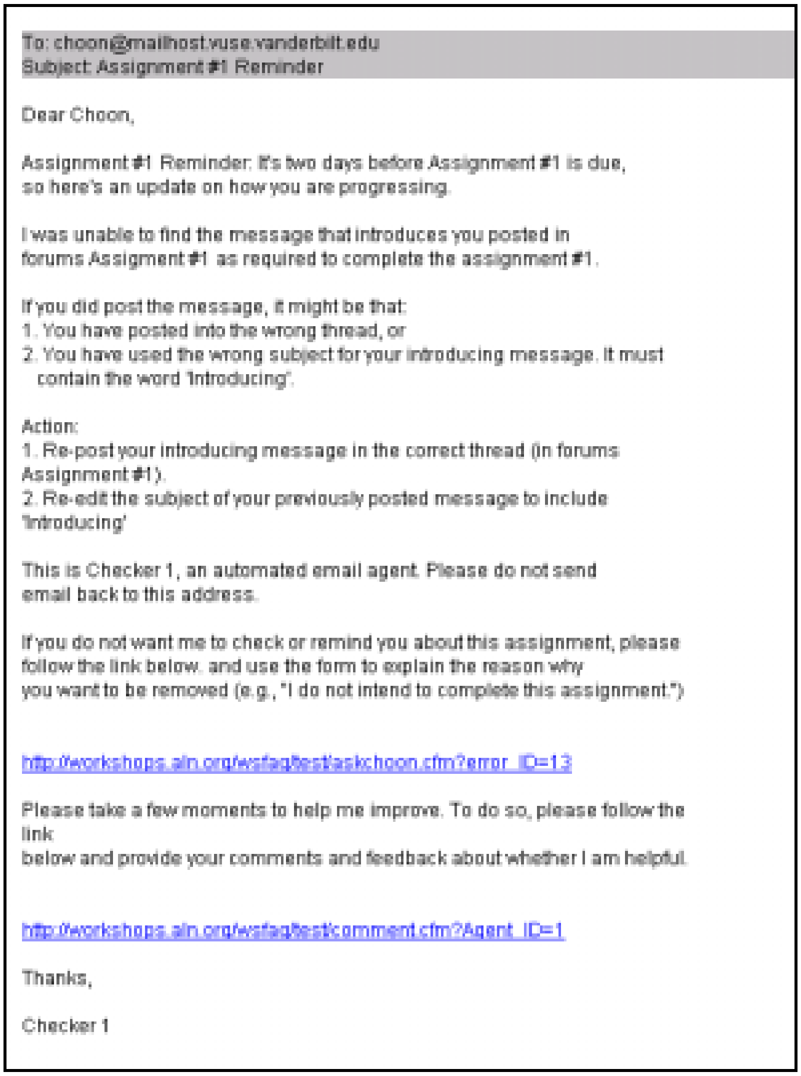
Thanks,

Checker 1

Figure 4. Illustration of a Sample Email Composed by the Email Agents of Scheduled KnowBots for Assignment #1 When the Assignment Has Been Determined as Complete

Figure 4 shows a sample of email sent to the participant when the status is determined as complete. This congratulates and provides the participant a hyperlink to the feedback form.

On the other hand, if the status has been determined as incomplete due to some specific reason such as the introduction message can not be found, the participant will receive another type of email such the one shown in Figure 5. The email gives details of the checking result and encourages the participant to complete the assignment. The message explicitly identifies the problem and points out some possible actions to take in order to help the participant to fix the problem. In addition, the message also contains hyperlinks to where the participant can find additional assistance on specific problems, and to where the participant can submit feedback and comments about using the KnowBots. The comments and feedback from the participant are considered to be crucial to future development and study of the KnowBots.



To: choon@mailhost.vuse.vanderbilt.edu
Subject: Assignment #1 Reminder

Dear Choon,

Assignment #1 Reminder: It's two days before Assignment #1 is due,
so here's an update on how you are progressing.

I was unable to find the message that introduces you posted in
forums Assigment #1 as required to complete the assignment #1.

If you did post the message, it might be that:
1. You have posted into the wrong thread, or
2. You have used the wrong subject for your introducing message. It must
contain the word 'Introducing'.

Action:
1. Re-post your introducing message in the correct thread (in forums
Assignment #1).
2. Re-edit the subject of your previously posted message to include
'Introducing'

This is Checker 1, an automated email agent. Please do not send
email back to this address.

If you do not want me to check or remind you about this assignment, please
follow the link below. and use the form to explain the reason why
you want to be removed (e.g., "I do not intend to complete this assignment.")

http://workshops.aln.org/wsfaq/test/askchoon.cfm?error_ID=13

Please take a few moments to help me improve. To do so, please follow the
link
below and provide your comments and feedback about whether I am helpful.

http://workshops.aln.org/wsfaq/test/comment.cfm?Agent_ID=1

Thanks,

Checker 1

Figure 5. Illustration of a Sample Email Composed by the Email Agents of Scheduled KnowBots for Assignment #1 When the Assignment Has Been Determined as Complete

Decision algorithm and flow diagram of on-demand KnowBots for Assignment #1

The only differences between the on-demand version of the KnowBots for Assignment #1 and the scheduled version are the way they are invoked and report the checking results. In Figure 6, the on-demand KnowBots are invoked by the request of individual user (participant). To check the assignment, the user or the participant must use his or her email address to identify him/herself and to invoke the checker. Similar to the scheduled KnowBots, the on-demand KnowBots use the email address as an identifier to identify the messages posted by the participant. The on-demand KnowBots use the same procedures as the scheduled ones, but

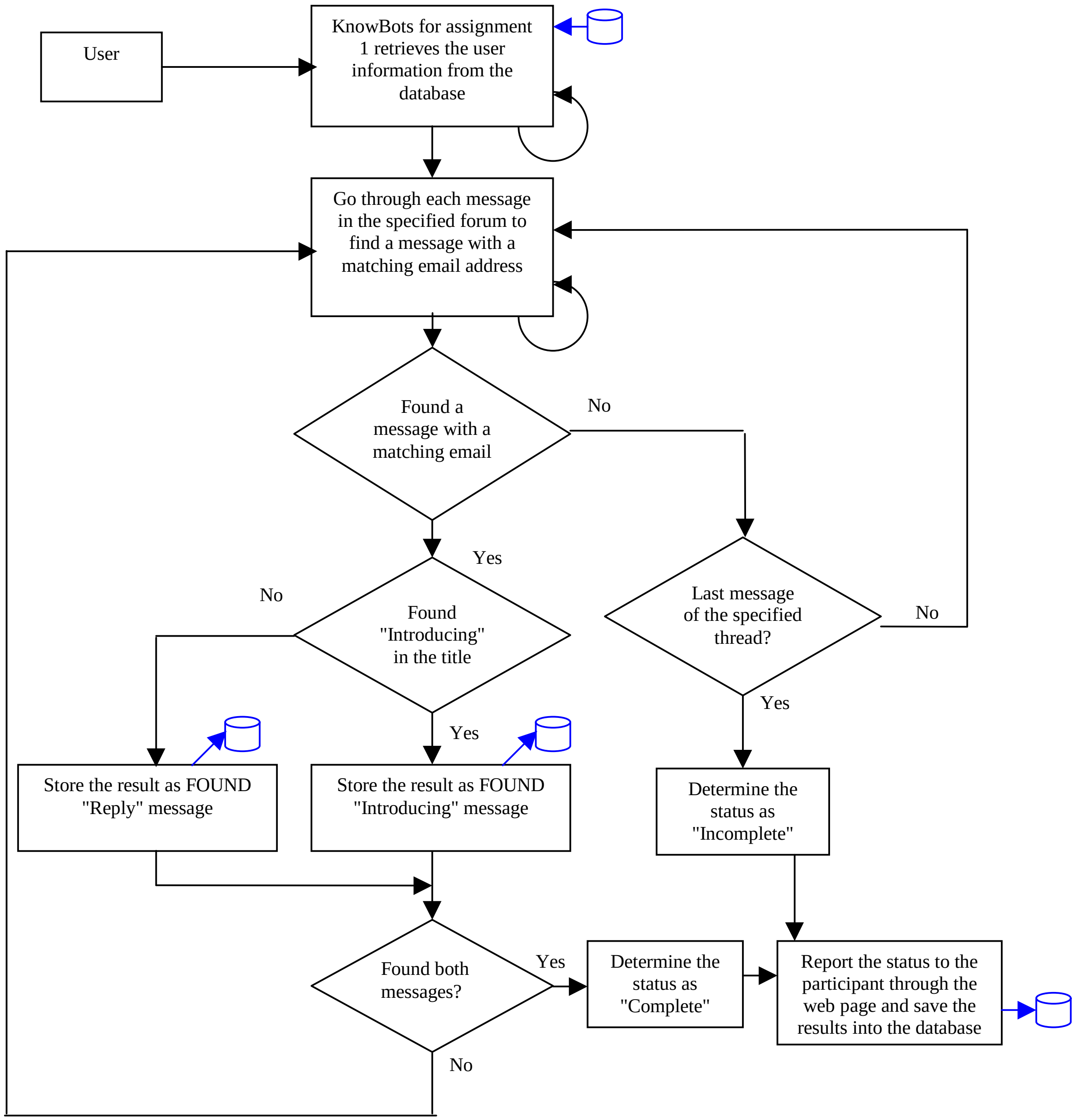


Figure 6. Decision Algorithm and Flow Diagram of On-demand KnowBots for Assignment #1

instead of reporting the results to the participant via email, they display the results on a web page. An additional email message may be generated and sent to the participant to re-assure the status of completion and to congratulate the participant.

KnowBots for Assignment #2

Assignment #2 of the ALN Workshop requires each participant to review a minimum of three on-line courses, and post one review message per course in three different threads in the specified forum of the conferencing system.

Decision algorithm and flow diagram of KnowBots for Assignment #2

Similar to the scheduled KnowBots for Assignment #1, on the specific dates the scheduler invokes the scheduled KnowBots for assignment #2 to determine the status of the assignment #2 for each participant.

Figure 7 illustrates the algorithm and flow diagram of scheduled KnowBots for Assignment #2. First, KnowBots for Assignment #2 retrieve the information of each participant from the knowledge base one at a time, using the email address as an identifier to identify messages posted by the participant. Then, by going through all messages in the each thread (course name) of the specified forum in the conferencing system, KnowBots look for at least one message of the participant that has a matching email. If three messages or more are found from three different threads of the specified forum, KnowBots determine the assignment status as complete. Otherwise, KnowBots determine the status as incomplete. If the status has been determined as complete, the email agents of KnowBots compose an email to be sent to the participant to report and elaborate the result. On the other hand, if the status of the assignment has been determined as incomplete, the composed email includes some message to encourage the participant to complete the assignment and hyperlinks to where to find additional help and submit comments.

Similar to the on-demand KnowBots for Assignment #1 on how they are invoked and how they report the results, on-demand KnowBots for Assignment #2 are invoked by a user, and report the checking result on a web page. Other than that, the algorithm and flow diagram are the same as the scheduled KnowBots for Assignment #2.

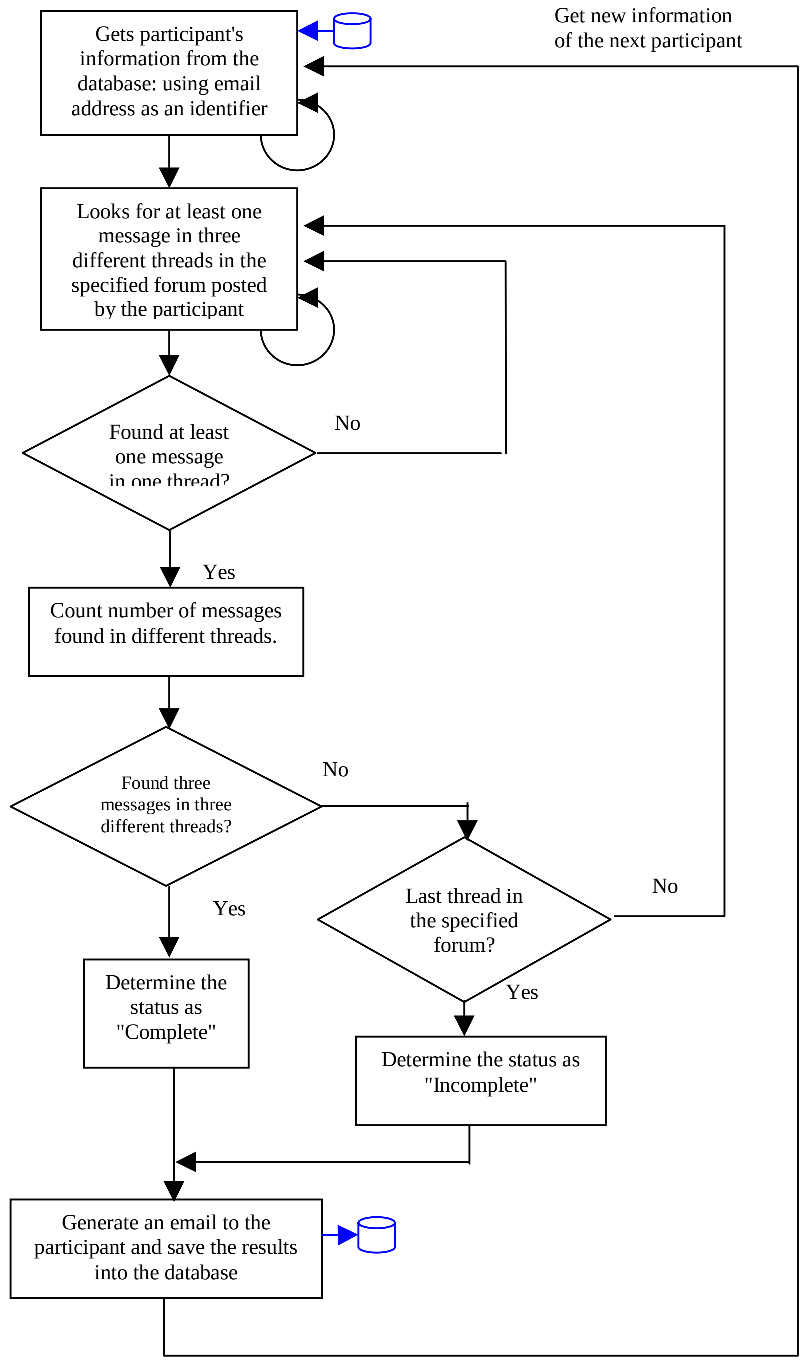


Figure 7. Decision Algorithm and Flow Diagram of KnowBots for Assignment #2

KnowBots for Assignment #3

Assignment #3 requires the participant to create a personal homepage in the assigned web space or the user directory of the ALN server (under folder ws_username of the ALN server).

The personal homepage must contain the required HTML codes, such as two different types of heading, one numbered list, etc. (See Appendix G for the details on the requirement for a certification of completion). The participant must also post two types of messages in the specified forum of the conferencing system. One message contains the link to the personal homepage. The other is to comment on another participant's homepage.

Decision algorithm and flow diagram of KnowBots for Assignment #3

Figure 8 illustrates the decision algorithm and flow diagram of scheduled KnowBots for Assignment #3. On the scheduled dates, KnowBots for Assignment #3 are invoked to check the status of all workshop participants according to the requirements. First, KnowBots obtain and use the user email address as an identifier of the participant through the communication with the knowledge base. Then KnowBots go through all messages in the specified forum of the conferencing system to find one message that contains a link to the participant's homepage and a reply message. If KnowBots find the message with the link to the personal homepage, KnowBots first determine whether the link resides within the ALN server. If it does, KnowBots follow the link to check if all required HTML codes could be found. KnowBots for Assignment #3 are also capable of verifying the status of the hyperlink to the homepage to determine whether it is broken, and report the error to the participant before making further attempts to find the HTML codes in the homepage. KnowBots examine the personal homepage of the participant by looking at certain HTML tags such as the <ol> and tag for number list, or <hr> tag for horizontal line. KnowBots store the results in detail in order to help the participant to quickly identify the problem, if the status of the homepage is determined to be incomplete. The email agents of KnowBots compose an email to the participant containing a detailed status report.

A user may also use on-demand KnowBots for Assignment #3 to verify the status of his or her personal homepage. On-demand KnowBots for Assignment #3 provide an immediate feedback and report of the status of the participant's homepage on web pages.

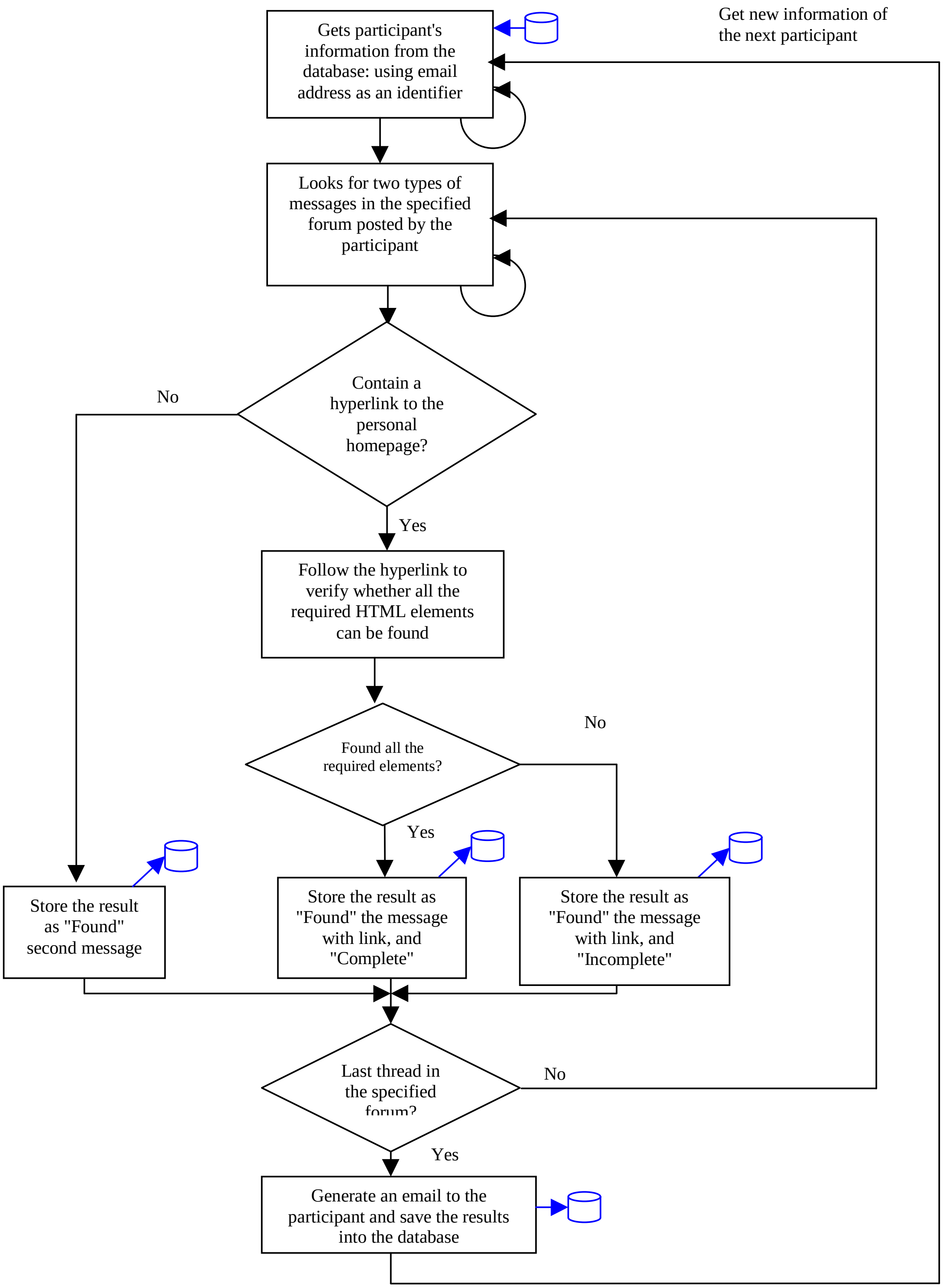


Figure 8. Decision Algorithm and Flow Diagram of KnowBots for Assignment #3

KnowBots for Assignment #4

Assignment #4 of the workshop requires the participant to create a course homepage and two additional course pages in the assigned directory. Similar to the requirement of Assignment #3, the course pages must contain certain HTML codes, but at a more advanced level.

Decision algorithm and flow diagram of KnowBots for Assignment #4

Figure 9 illustrates the decision algorithm of scheduled KnowBots for Assignment #4. Same as the other scheduled KnowBots of the previous assignments, the scheduled KnowBots for assignment #4 are invoked by the scheduler to check the status of Assignment #4 for all workshop participants. The algorithm and flow diagram of KnowBots for Assignment #4 are somewhat similar to that of KnowBots for Assignment #3 in that KnowBots use the participant's email address as an identifier to look for messages in the conferencing system that contains links to a course homepage. KnowBots for Assignment #4 differ from KnowBots for Assignment #3 in that they are capable of crawling from the main course homepage to the other course pages within the same directory.

The finding results of all the required HTML codes from each page are accumulated until KnowBots reach the last course page found in the participant's directory in order to determine the final status.

The email agents of the KnowBots are responsible for composing an email reporting the checking status, with details, to be sent to the participant. The email message provides some guidelines of what the problems could be and how to fix them.

The on-demand version of KnowBots for Assignment #4 also gives a participant the ability to check his or her assignment at any time and view a result web page composed by the user-interface agents.

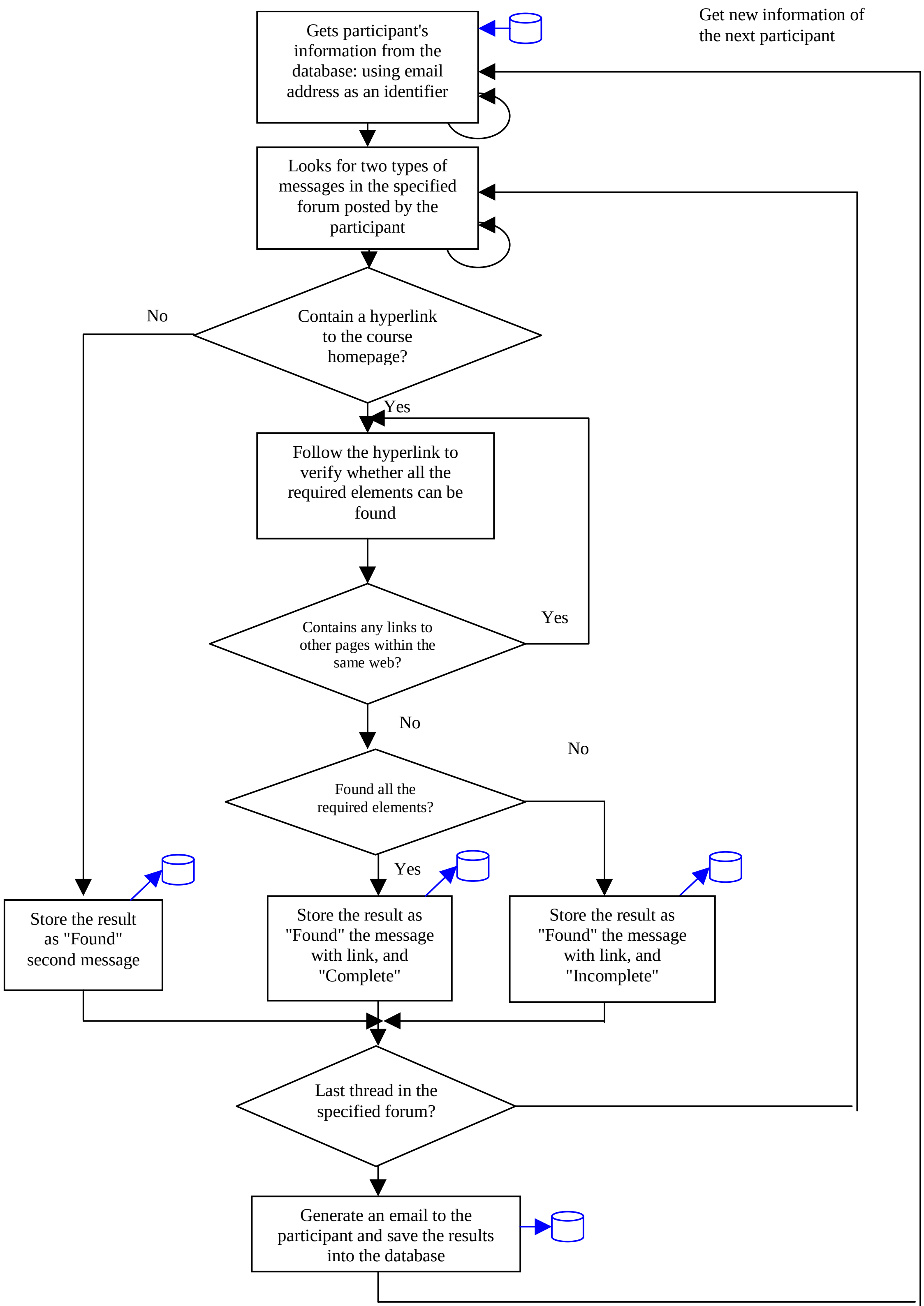


Figure 9. Decision Algorithm and Flow Diagram of KnowBots for Assignment #4

KnowBots for Assignment #5

Assignment #5 of the workshop requires the participants to apply even more advanced features of FrontPage to their course page, such as themes, frames, image maps, forms, navigation bars or shared borders.

Decision Algorithm and Flow Diagram of KnowBots for Assignment #5

Figure 10 illustrates the decision algorithm and flow diagram of KnowBots for Assignment #5. With the same logical algorithm applied for KnowBots for Assignment #3 and #4, KnowBots for Assignment #5 provide a detailed report as well as provide assistance to the participant to complete the required tasks. The participant also can use the on-demand KnowBots for assignment #5 to verify the completion of the assignment at any time.

KnowBots for Assignment #6

Assignment #6 requires the participant to create three out of five requirements and place them in the user directory. For instance, a PowerPoint presentation converted to HTML, a PowerPoint presentation with audio, a multiple choice quiz or form, etc. (For details on the requirements for completion of this assignment, see Appendix G).

Decision Algorithm and flow diagram of KnowBots for Assignment #6

Since the requirements of this assignment are too flexible for KnowBots to be fully automated, KnowBots for assignment #6 mainly assist both participants and facilitators in order to help the participant to complete the assignment. The user-interface agents of the KnowBots for assignment #6 compose a submission form for the participant to submit the assignment to the facilitator for review. The email agents of the KnowBots compose an email to notify the facilitator about the participant's new submission to the system. The notification email includes a hyperlink associated with the information of who made the submission and when it was submitted. Facilitators receive the notification email and follow the link to perform the checking

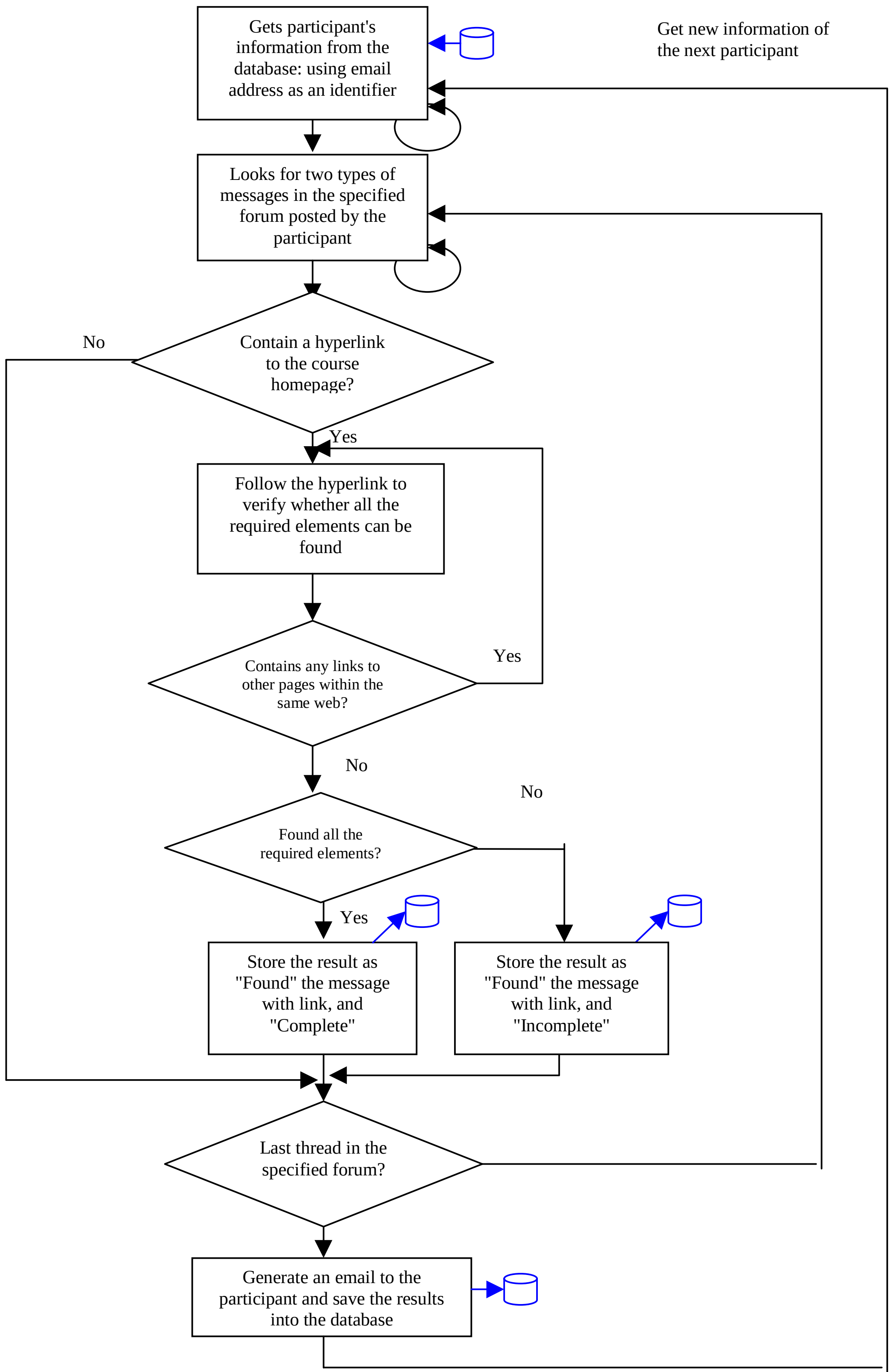


Figure 10. Decision Algorithm and Flow Diagram of KnowBots for Assignment #5

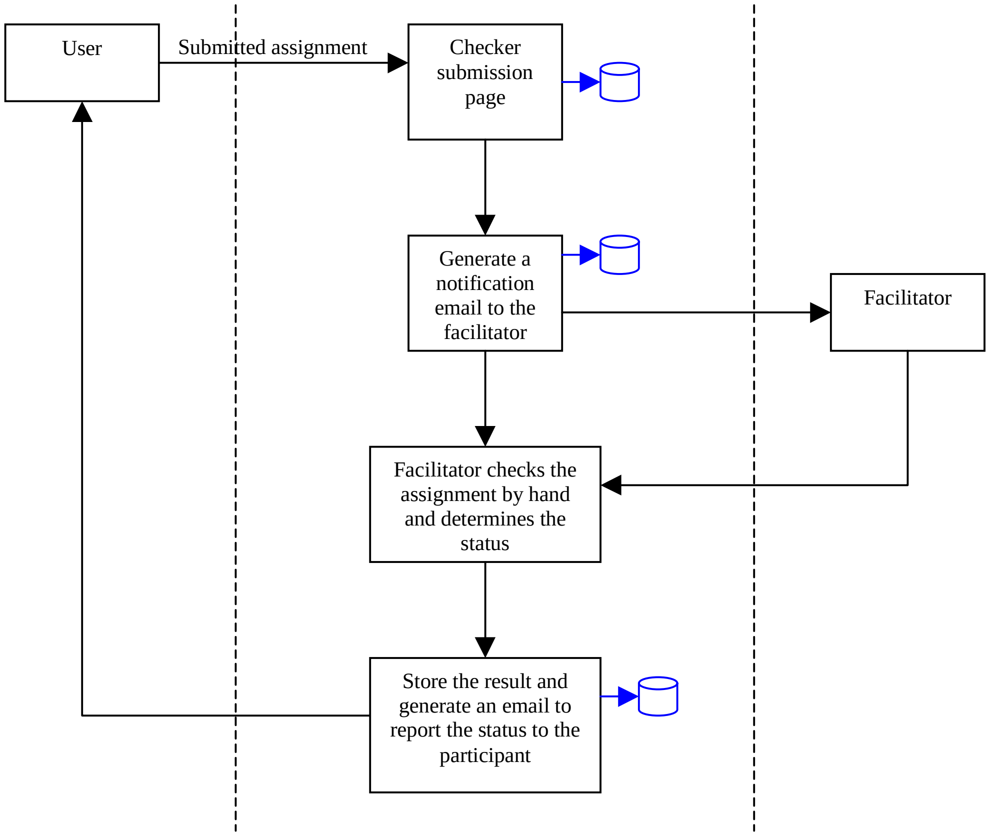


Figure 11. Decision Algorithm and Flow Diagram of KnowBots for Assignment #6

assignment task. The user-interface agents compose a submission-checking page associated with other helpful information to be presented to the facilitator. This submission-checking page helps the facilitators to find the location of submission more quickly than if they have to be it without the assistance from KnowBots.

After carefully checking the submission, the facilitator submits the results, both partial and overall, accompanied by comments, into the KnowBots system. Here again, the email agents of the KnowBots compose an email to be sent to the participant associated with detailed comments from the facilitator. KnowBots of Assignment #6 record all of these activities into the log file and the knowledge base.

KnowBots for Assignment #7

Assignment #7 of the workshop requires the participants to create a discussion web with FrontPage, and post a message in the specified forum of the conferencing system.

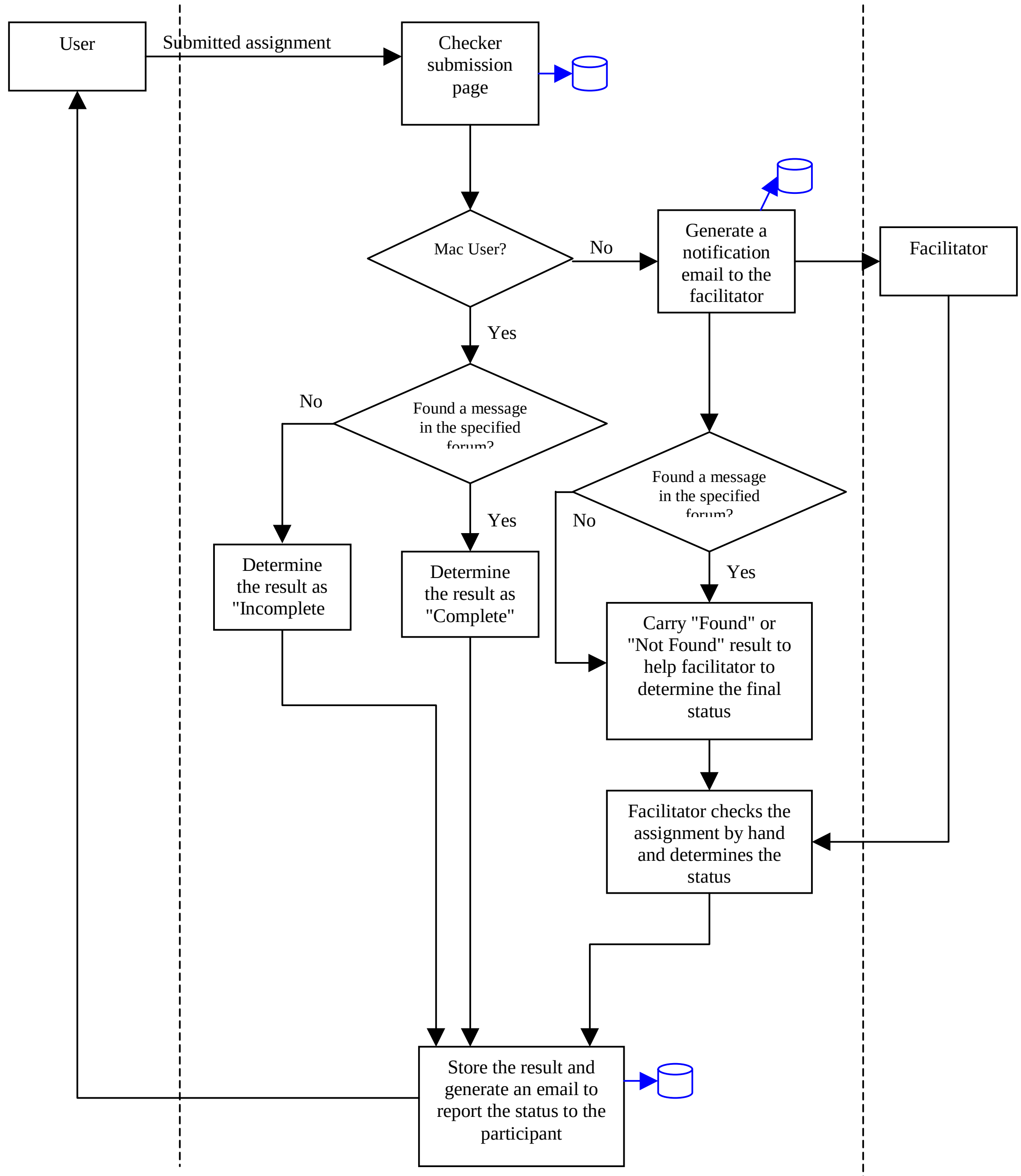


Figure 12. Decision Algorithm and Flow Diagram of KnowBots for Assignment #7

Decision Algorithm of KnowBots for Assignment #7

Again, since the requirements of this assignment are too flexible (e.g., Mac users cannot create discussion forum using FrontPage for Mac), KnowBots for this assignment cannot be fully automated. KnowBots for Assignment #7 provide a submission form for the participant to submit to the facilitator for review. In the submission form, the participant first is asked to identify whether he or she is a Mac user. If the participant is not a Mac user (PC user), he is required to provide the URL to his discussion forum page in his web. If the participant is a Mac user, then KnowBots can automatically determine the assignment status by simply looking at whether there is a message posted by the participant in the specified forum. Then after a non-Mac user submits the required information through the KnowBots system, the email agents of KnowBots for Assignment #7 compose an email to notify the facilitator about the incoming submission to the system. Again, the email message contains necessary information such as the link to the submission-checking page, who submitted it and when it was submitted. The facilitator can survey the results composed by the user-interface agents to help determine the final status of assignment. After carefully checking the participant's submission, the facilitator submits the checking results through the user-interface agents. Then the email agents compose an email reporting the results to the participant.

KnowBots for Assignment #8

Assignment #8 of the workshop requires the participant to post a message in the specified forum of the conferencing system to discuss the benefits of using a synchronous discussion tool like NetMeeting.

Decision Algorithm of KnowBots for Assignment #8

Because the requirement of this assignment is fairly simple, KnowBots for this assignment can determine the completion status of the participant by simply checking whether a message posted by the participant can be found in the specified forum. Then, KnowBots generate a report presented on a web page as well as compose an email to re-assure the completion status to the participant.

KnowBots for Assignment #5 and #6 may not be considered as a fully automated tool for performing the assignment-checking task. However, KnowBots of these specific assignments greatly reduces the time facilitators have to spend locating where the participant may have placed the assignments in the directory.

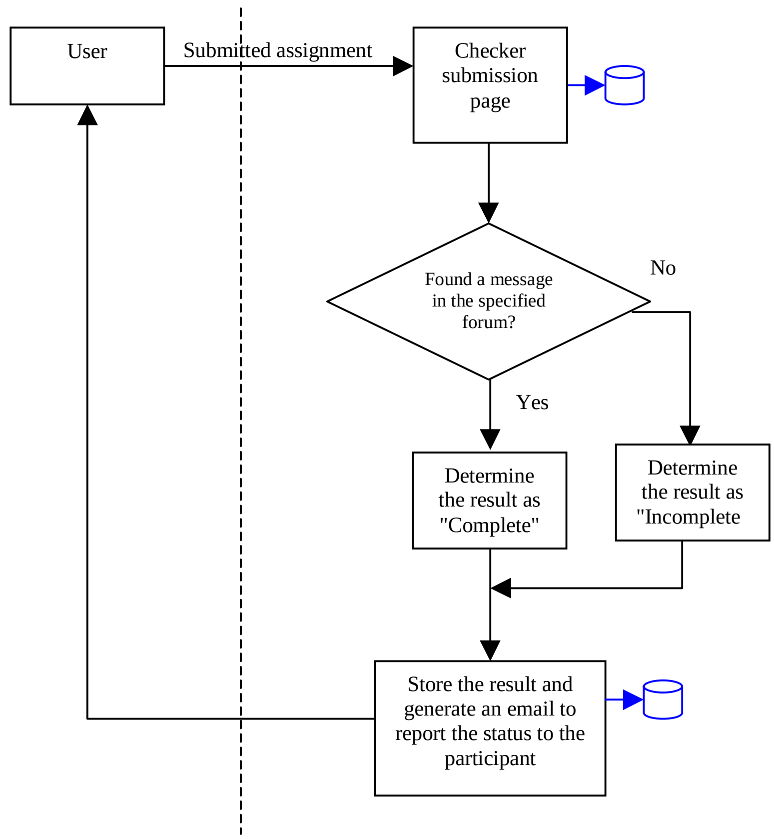


Figure 13. Decision Algorithm and Flow Diagram of KnowBots for Assignment #8

As a result, even use of this semi-automated tool may result in a quicker response time since KnowBots automatically generate a notification email to both parties as soon as something has been submitted into the system.

CHAPTER V

RESULTS AND ANALYSES

Our primary hypothesis is that adopting intelligent agent techniques such as KnowBots to the ALN workshop will result in improving the completion rates of the workshop. This section of the study presents experimental data and analyses to confirm or reject this hypothesis.

A number of hypotheses have been proposed to test the effects of the use of KnowBots on workshop completion rates:

1. The use of KnowBots to the ALN Workshop learning environment improves the completion rate (percentage number).
2. The use of KnowBots to the ALN workshop reduces facilitation time.
3. The use of KnowBots increases the participation of workshop participants.
4. More frequent use of KnowBots may result in a higher completion rate.

In order to investigate the effects of the dependent variable and the intervening variables to the percentage of workshop completion, a number of statistical analyses were performed in order to test the hypotheses.

- T-test analysis of completion rate between groups
- T- test analysis of facilitation time between participant groups
- Correlation analysis between number of times using the KnowBots and number of assignments completed by the participants
- Correlation analysis between number of times using the KnowBots and number of times the participant accesses the learning material
- Correlation analysis between number of times participants use the KnowBots and number of messages posted in the conferencing system by the participant
- Correlation analysis between average number of messages posted by the participants and number of assignments completed

The major results are presented as follows:

Differences in Completion Rates

Table 6 below summarizes number of participant of each session and the selection of treatment:

Table 6 Number of Participants and the Selection of Treatment

Session	Control group	Treatment groups
May-98 (number of participants)	(220)	
September-98 (number of participants)		(98)
January-99 (number of participants)		(64)

Figure 14 shows the percentage of workshop completion and assignment completion of the May-98 session is presented as follows (before using the KnowBots system).

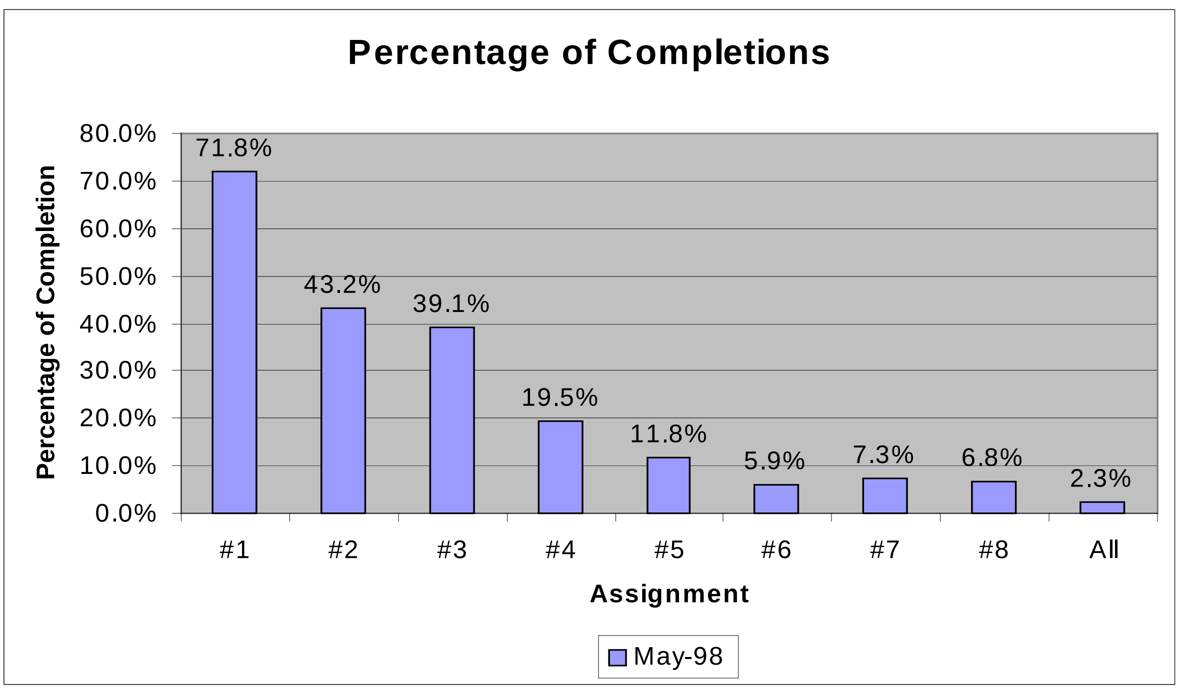


Figure 14. Percentage of Workshop Completion before the Use of KnowBots

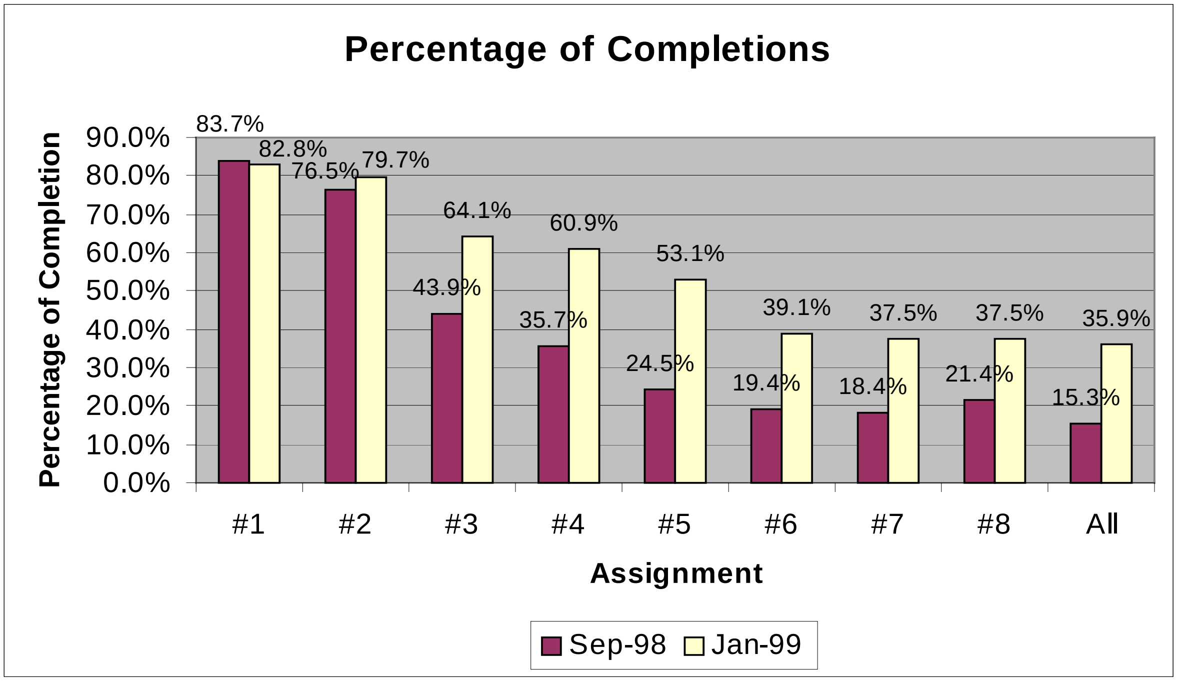


Figure 15. Percentage of Workshop Completions after the Use of KnowBots

Figure 15 shows the percentage of workshop and assignment completions of the September-98 and January-99 sessions (after the use of KnowBots). Figure 14 and 15 clearly showed that the two sessions that received help from KnowBots (September-98 and January-99 sessions) had higher completion rates than the May-98 session, when no help was provided by KnowBots.

There was no evidence found to indicate that there were any differences between the three experimental groups. The constituency of the group varied between different disciplines (nursing, engineering, etc.), but no group dominated any session. Participants randomly spread up for the workshops. Hence, it was assumed that participant differences did not affect retention rates found between the groups.

Therefore, to test whether introducing KnowBots to the workshop learning environment in September-98 made a significant difference in the assignment completions of the workshop, a t-test analysis was employed to test whether there was a significant difference between the mean assignment completions (i.e., average number of assignments completed) of the May-98 session and the mean assignment completions of the September -98 session.

Results from the t-test analysis between two sessions of the workshop (May-98 and September-98 sessions) are presented in Figure 16. From the analysis, the mean assignment completion of the September-98 session participant group is equal to 3.08 with a 2.61 standard deviation. And the mean assignment completion of the May-98 session participant group is equal to 2.14 with a 2.22 standard deviation.

The obtained value t = 3.20 from t-test analysis is evaluated with Table A2 (Table of Student's t Distribution) in Appendix A. The value of degrees of freedom for the t-test, DF, is equal to 180. Noticing that there is not a big difference between the critical values at DF = 120 and DF = infinity in the Table A2, for example, the two-tailed critical value $t_{.05}$ where DF = 120 is 1.980 and the $t_{.05}$ where DF = infinity is 1.960, the degrees of freedom = infinity is employed.

The critical t value for DF = infinity are summarized in Table 7:

Table 7 Table of Critical .05 and .01 t Values, DF = Infinity

	$t_{.05}$	$t_{.01}$
Two-tailed values	1.960	2.576
One-tailed values	1.645	2.326

Employing the guideline for evaluating the t-value, this conclusion reached the directional alternative hypothesis H_1: $\mu_1 > \mu_2$ at both of the pre-specified level of significance $\alpha = .05$ and $\alpha = .01$. Hence, it can be concluded that the average (or mean) assignment completions for the group that received help from the KnowBots (September-98 session) is significantly greater than the average (or mean) assignment completions for the group that did not receive help from the KnowBots (May-98 session). This can be summarized as follows t (180) = 3.20, where p = 0.0016 (or p < 0.01).

Two Sample T-Test and Confidence Interval

Two sample T for Number of Assignments Completed in September-98 session vs. Number of Assignments Completed in May-98 session

Number of Assignments Completed by Participants	**N**	**Mean**	**StDev**	**SE Mean**
September-98 session	98	3.08	2.61	0.25
May-98 session	220	2.14	2.22	0.15

95% Confidence Interval for $\mu_{September-98} - \mu_{May-98}$: (0.36, 1.52)

T-Test $\mu_{September-98} = \mu_{May-98}$ (and not equal): T = 3.20, P = 0.0016, DF = 180

$\mu_{September-98}$: the mean of number of assignments completed by participants in September-98 session, μ_{May-98}: the mean of number of assignments completed by participants in May-98 session

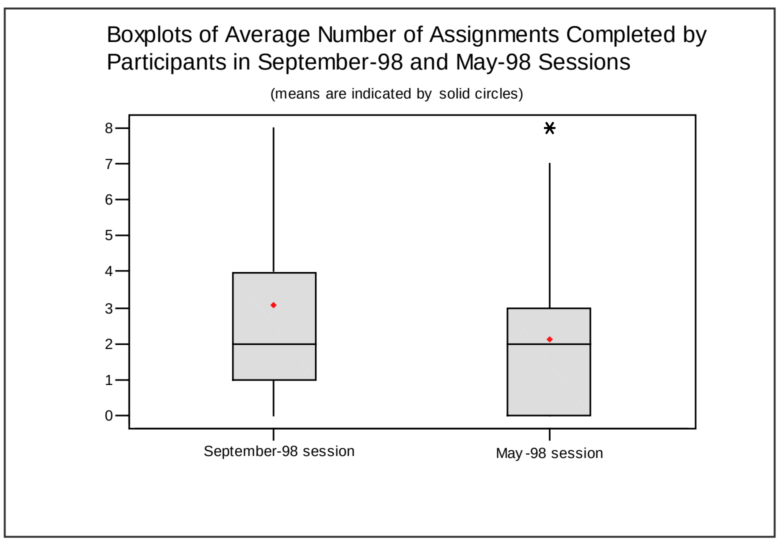


Figure 16. t-test Analysis between Number of Assignments Completed by Participants from May-98 Session and September-98 Session

Examine the boxplot of the mean of number of assignments completed by the participants from the September-98 and May-98 session. The line drawn across each box indicated the median, or middle, of the data. The bottom edge and top edge of the box mark the first (25^{th} percentile) and third (75^{th} percentile) quartiles, respectively.

The boxplots suggest that the participants from the September-98 session completed more assignments than the participants from the May-98 session.

Similarly, another t-test analysis was performed on the number of assignment completions of the participant group from the May-98 session (before the use of KnowBots) and the number of assignment completions of the participant group from January-99 session (2^{nd} session that used the KnowBots). To test whether there is a significant different in the mean number of assignment completions between the two groups, the results from t-test are presented in Figure 17. Employing the same guidelines to evaluate the t-value, the mean of the number of assignment completions by the participant group from January-99 session is significantly greater than the mean number of assignment completion by the participant group from the May-98 session. Hence, it can be concluded that the average (or mean) assignment completions for the group that received help from the KnowBots (January-99 session) is significantly greater than the average (or the mean of) assignment completions for the group that did not receive help from the KnowBots (May-98 session). This can be summarized as follows $t(83) = 5.96$, where $p = 0.0000$ (or $p < 0.01$).

Two Sample T-Test and Confidence Interval

```
Two sample T for Number of Assignments Completed in January-99 session vs.
Number of Assignments Completed in May-98 session
```

Number of Assignments Completed by Participants	**N**	**Mean**	**StDev**	**SE Mean**
January-99 session	64	4.58	3.04	0.38
May-98 session	220	2.14	2.22	0.15

95% Confidence Interval for $\mu_{January-99} = \mu_{May-98}$: (1.62, 3.25)

T-Test $\mu_{January-99} = \mu_{May-98}$ (and not equal): T = 5.96 P = 0.0000 DF = 83

$\mu_{January-99}$: the mean of number of assignments completed by participants in January-99 session, μ_{May-98}: the mean of number of assignments completed by participants in May-98 session

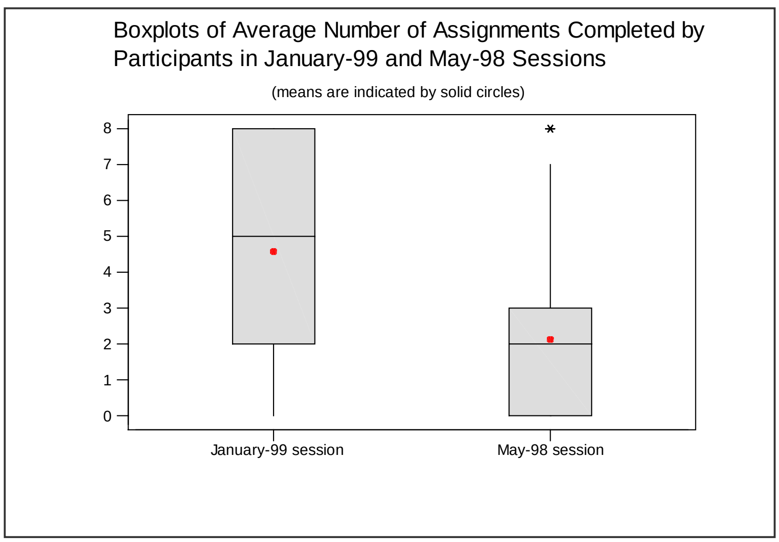


Figure 17. t-test Analysis between Number of Assignments Completed by Participants from May-98 Session and January-99 Session

From the results from the t-test analyses above, it may be concluded that there is a significant difference in the number of assignment completions between the groups that received help from KnowBots (September-98 and January-99 sessions) and the group that did not receive help from KnowBots (May-98 session).

Differences in Facilitation Time

To measure the facilitation time, it is assumed that the total number of messages posted by facilitators in the conferencing system could well represent the total estimated time of workshop facilitation.

Table 8 presents data analyzed from the conferencing system's database of each workshop session. The total facilitation time on item #4 was determined from the amount of time estimated that the facilitator may spend responding to the question (or request-for-help message) posted in the conferencing system. First, the total number of messages posted in the conferencing system were gathered accompanied by the question or message that each message may have responded to. Then the time spent was according to the complexity of the messages (Table 9). It is assumed that the more complex the message or question was, the more time the facilitator would have to spend answering the questions.

Figure 18 presents the comparison of percentages of facilitation messages posted in the conferencing system of each session over the total number of messages posted in the conferencing system of each session.

Table 8 Data Analyzed to Determine Facilitation of Each Workshop Session

Item#	item detail	May-98	Sept-98	Jan-99
1	Number of participants	220	98	64
2	Total number of messages in the conferencing system of the specific session	2832	2240	1419
3	Total number of facilitation messages	349	329	158
4	Total time spent (minutes) *	3019	2015	994
5	**Percentage of facilitation messages over total messages (item#3 / item#2)**	**12.32%**	**14.69%**	**11.13%**
6	**Number of messages posted by facilitators per participants (item#3 / item#1)**	**1.6**	**3.4**	**2.5**
7	**Facilitation time spent per participant (minutes)**	**13.7**	**20.6**	**15.5**

Note: Total time spent was determined from the total amount of time facilitators spent on each facilitation message. Time spent on each message was estimated based on complexity of each message in Table 9. Assuming that the more complex message take more time for facilitator to answer.

Table 9 Complexity Scales of Facilitation Message

Complexity scale	Description	Time estimated
5	Most complex, very difficult problem	>15 min (use 20 min avg.)
4	Complex, difficult	13-15 min (use 14 min avg.)
3	Fair	8-12 min (use 10 min avg.)
2	Easy	4-7 min (use 5 min avg.)
1	Fairly easy	1-3 min (use 2 min avg.)
0	Not relevant or no content message	0 min

Sample of messages for each level of complexity message can be found in Appendix C.

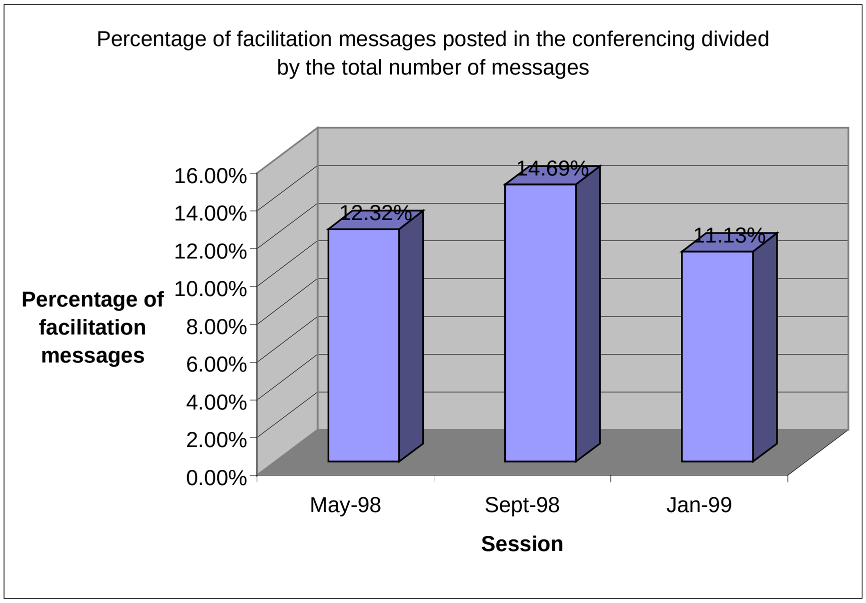


Figure 18. Percentage of Facilitation Messages Divided by the Total Messages Posted in Each Session Conferencing System

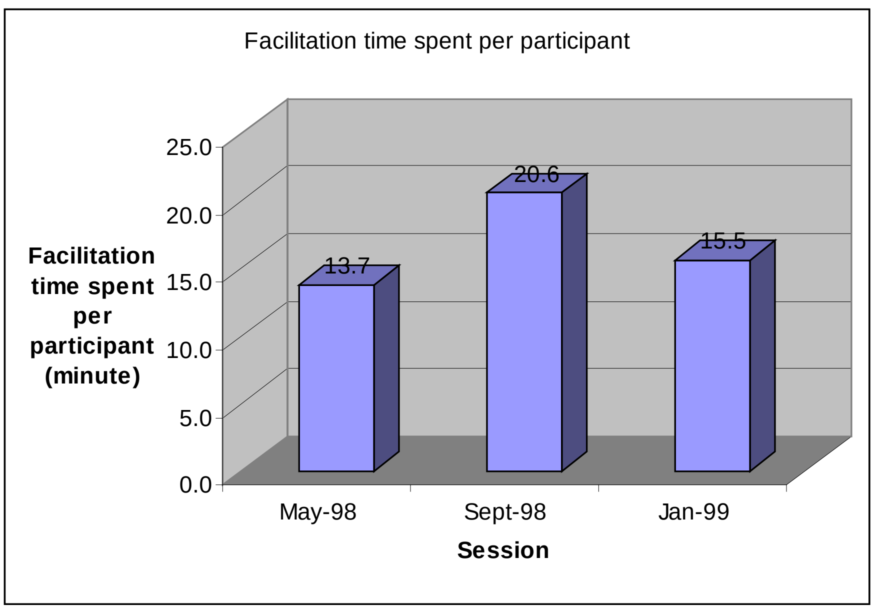


Figure 19. Facilitation Time Spent per Participant

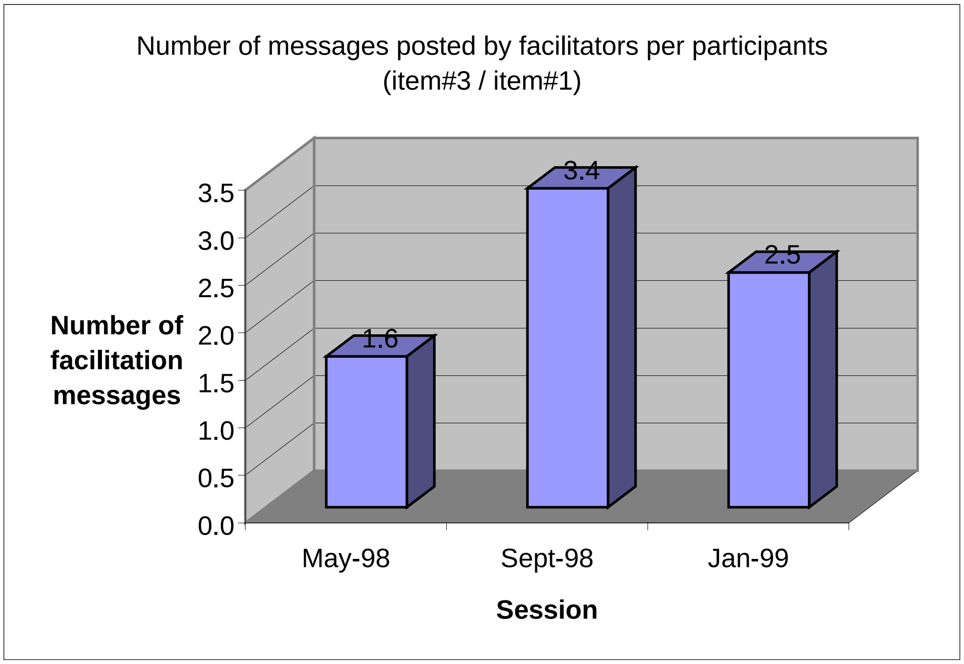


Figure 20. Average Number of Facilitation Messages per Participant of Each Workshop Session

The data presented above indicate that when KnowBots were first introduced to the September 98 session, the average number of facilitation messages per participant (Figure 20) was increased more than twice of the average facilitation messages per participant of the May-98 session. This number reflected the similar higher average facilitation time per participant (Figure 19) and the higher percentage of facilitation messages over the total messages posted (Figure 18) between May-98 and September-98 sessions.

This is clearly contrary to the initial expectation that the use of KnowBots would reduce the facilitation time. To rationalize these results, discussion on this contradiction will be explained in the Discussion and Conclusion section of this study.

Difference in Number of Messages Posted in the Conferencing System by Participants

To measure the participation of the workshop participant, it is assumed that the average number of messages posted by the participants in the conferencing system could represent the degree of participation of the workshop participant of each session of the workshop.

Table 10 Results of Data Analysis for Determining Average Number of Messages Posted by Participants

Item #	Item detail	May-98	Sept-98	Jan-99
1	Number of participants	220	98	64
2	Percentage number of workshop completions	2.3%	15.3%	35.9%
3	Total number of messages posted by participants	2300	1709	1181
4	Total number of messages posted by participants (excluding number of messages related to the checkers) **	2300	1639	1160
5	**Number of messages posted by participants per participant (#3 / #1)**	**10.45**	**17.44**	**18.45**
6	**Number of messages posted by participants per participant (#4 / #1)**	**10.45**	**16.72**	**18.13**

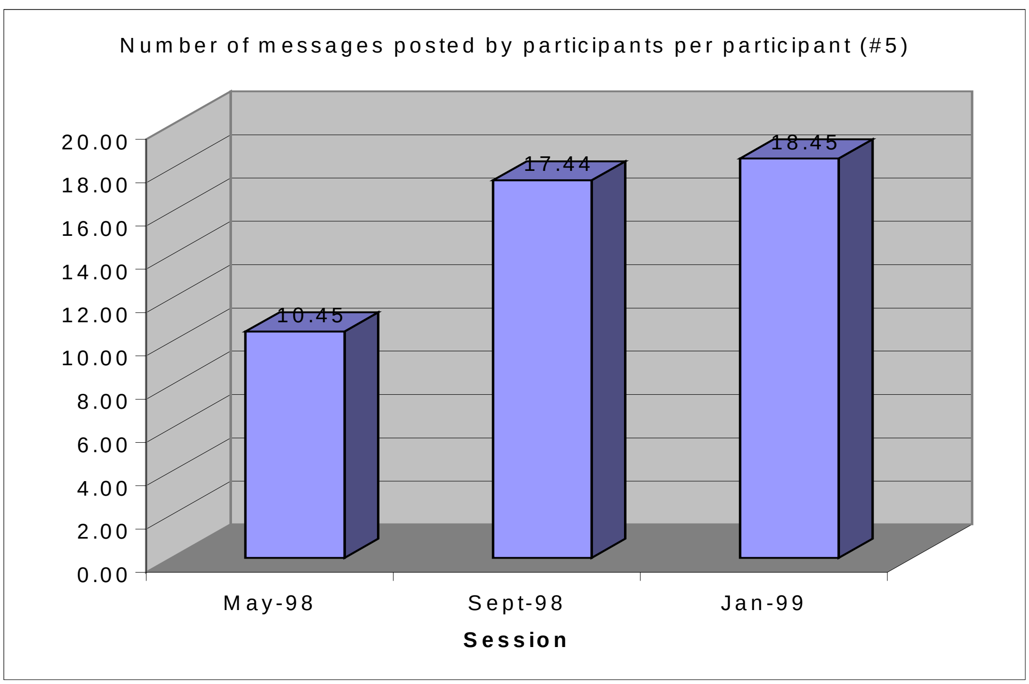


Figure 21. Average Number of Messages Posted by Participants per Participant

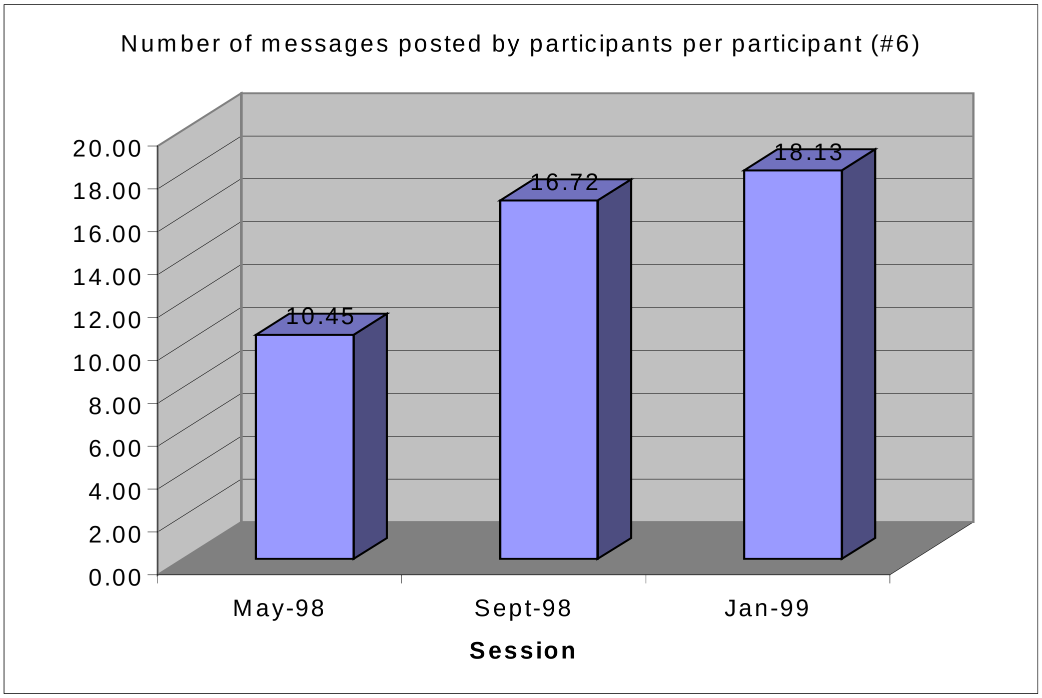


Figure 22. Average Number of Messages Posted by Participants per Participant (Number of Messages Related to KnowBots Was Removed)

Figure 21 and 22 above show that the average number of messages posted by participants per participant in the conferencing system increased after the addition of KnowBots to the workshop. Therefore, it may be concluded that the use of KnowBots improves number of postings (learner participation) in the conferencing system.

Figure 23, 24, and 25 below present the simple bivariate plots or the scatterplots between the number of postings by the participants of each session and the number of assignments completed.

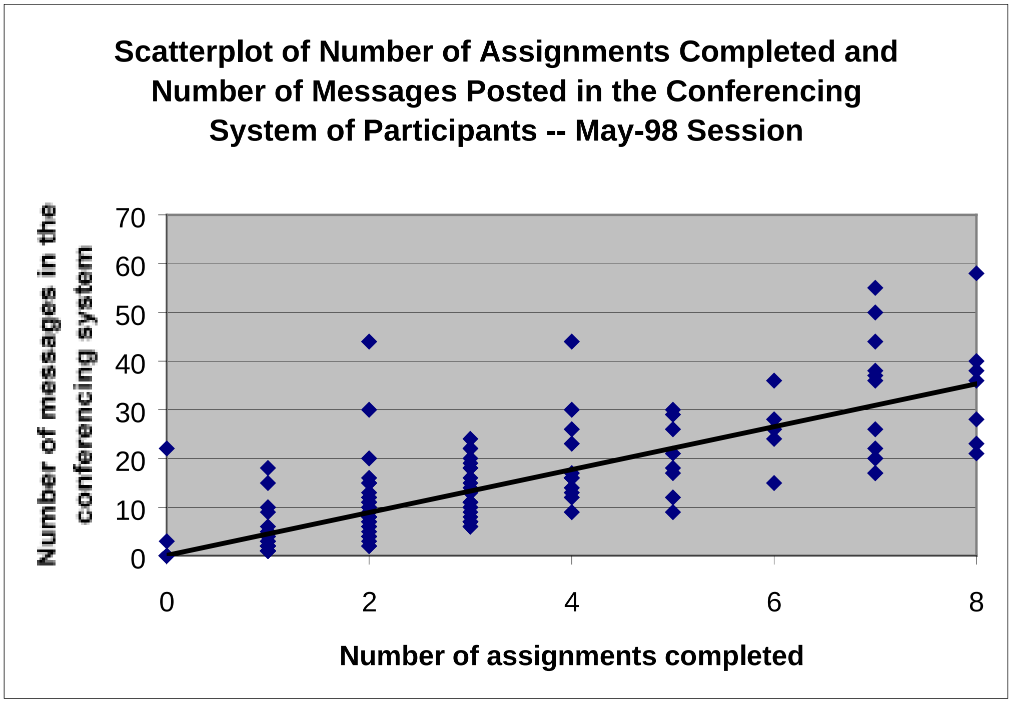


Figure 23. Simple Bivariate Plot or Scatterplot of Number of Assignments Completed and Number of Postings by the Participants of May-98 Workshop Session

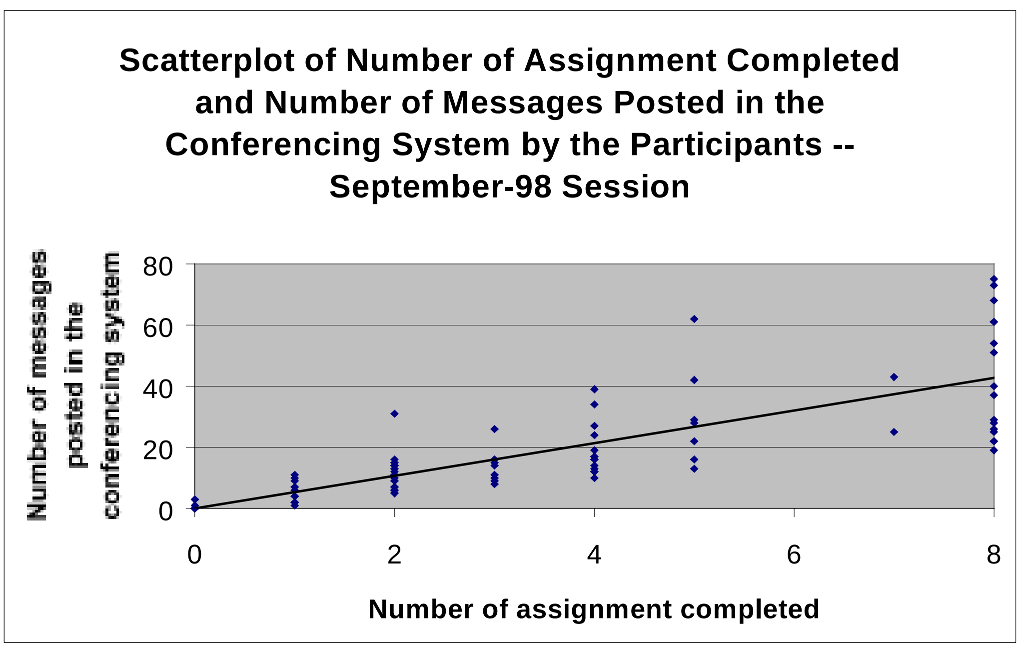


Figure 24. Simple Bivariate Plot or Scatterplot of Number of Assignments Completed and Number of Postings by the Participants of September-98 Workshop Session

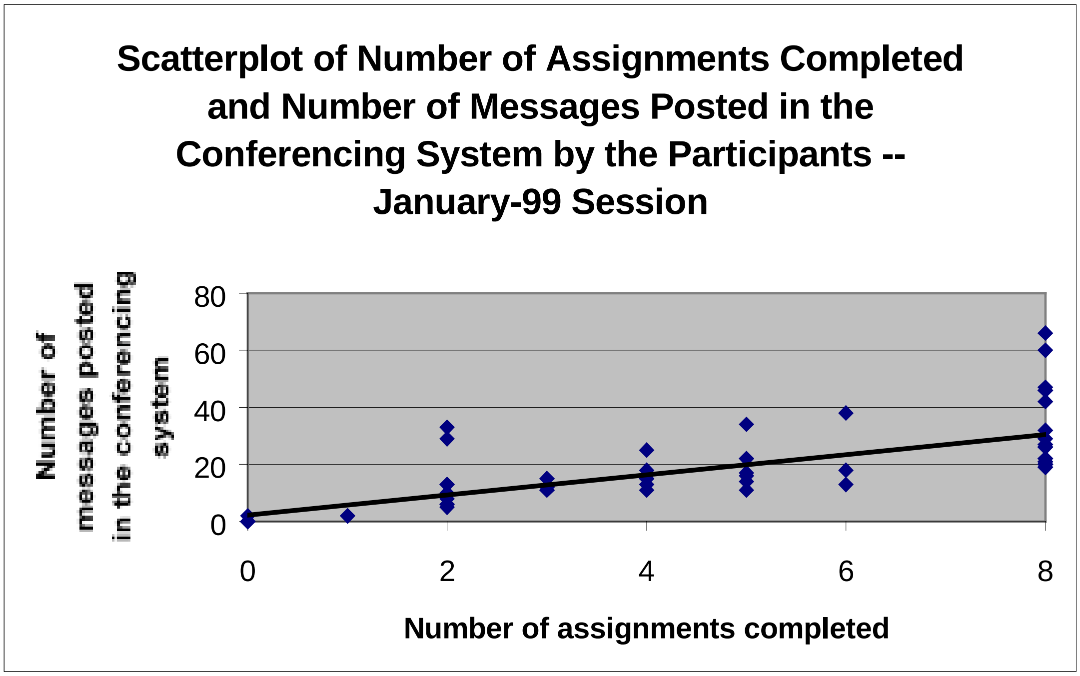


Figure 25. Simple Bivariate Plot or Scatterplot of Number of Assignments Completed and Number of Postings by the Participants of January-99 Workshop Session

Figures 23, 24 and 25 help to support that the number of postings in the conferencing system by the participant in each session is positively associated with the number of assignments completed. The results from t-test analysis also support that there are significant differences between the mean number of postings by the participants in the May-98 session and the mean number of postings by the participants in the September-98 session ($t(154)=3.78$, $p<0.01$) and by the participants in the January-99 session ($t(87) = 4.46$, $p<0.01$). Hence, these data support that the use of KnowBots improves the number of postings (learner participation) in the conferencing system in September-98 and January-99 sessions.

Correlation Analysis between Number of Times Using the KnowBots, Number of Assignments Completed, and Number of Visits to the Learning Material

Table B-1 in Appendix B presents data on the number of visits to the learning material, the number of assignments completed, and the number of times using the KnowBots by each participant in the January-99 session. Figure 26 below shows the correlation matrix between each pair of variables (January-99 session):

Correlations (Pearson)

January-99 session

	Number of Visits	Number of Assignments Completed
Number of Assignments Completed	0.432 0.000	
Number of Times Using KnowBots	0.258 0.043	0.655 0.000

Cell Contents: Correlation (r, correlation coefficient)
P-Value

Figure 26. Correlation Matrix of Number of Time Using the KnowBots, Number of Assignments Completed, and Number of Visits to the Learning Material of Participants in January-99 Workshop Session

To determine the Critical Values for Pearson, Table A16 from Appendix A was used where degrees of freedom, DF = 60. The tabled critical two-tailed r-values at the .05 and .01 levels of significance are $r_{.05} = .250$ and $r_{.01} = .325$, and the tabled critical one-tailed r-values at the .05 and .01 levels of significance are $r_{.05} = .211$ and $r_{.01} = .295$.

<u>Correlation analysis between number of visits and number of assignments completed (January-99 session)</u>

Employing the guideline for Pearson correlation analysis, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value $r = 0.432$ is a positive number that is greater than all tabled critical values (critical one-tailed values $r_{.05} = .211$ and $r_{.01} = .295$, critical two-tailed values $r_{.05} = .250$ and $r_{.01} = .325$). Therefore, it can be considered that the number of visits to the learning material and the number of assignments completed have <u>moderate positive correlation</u>. By employing Fisher's transformation to determine the 95% confidence interval for the computed value $r = 0.432$, the true correlation value ρ can be written as follows: 0.205 ≤ ρ ≤ 0.616. Note that because of the fairly small sample size of this session of the workshop, the range of values that define the confidence interval is quite large. The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also supports this correlation as presented below:

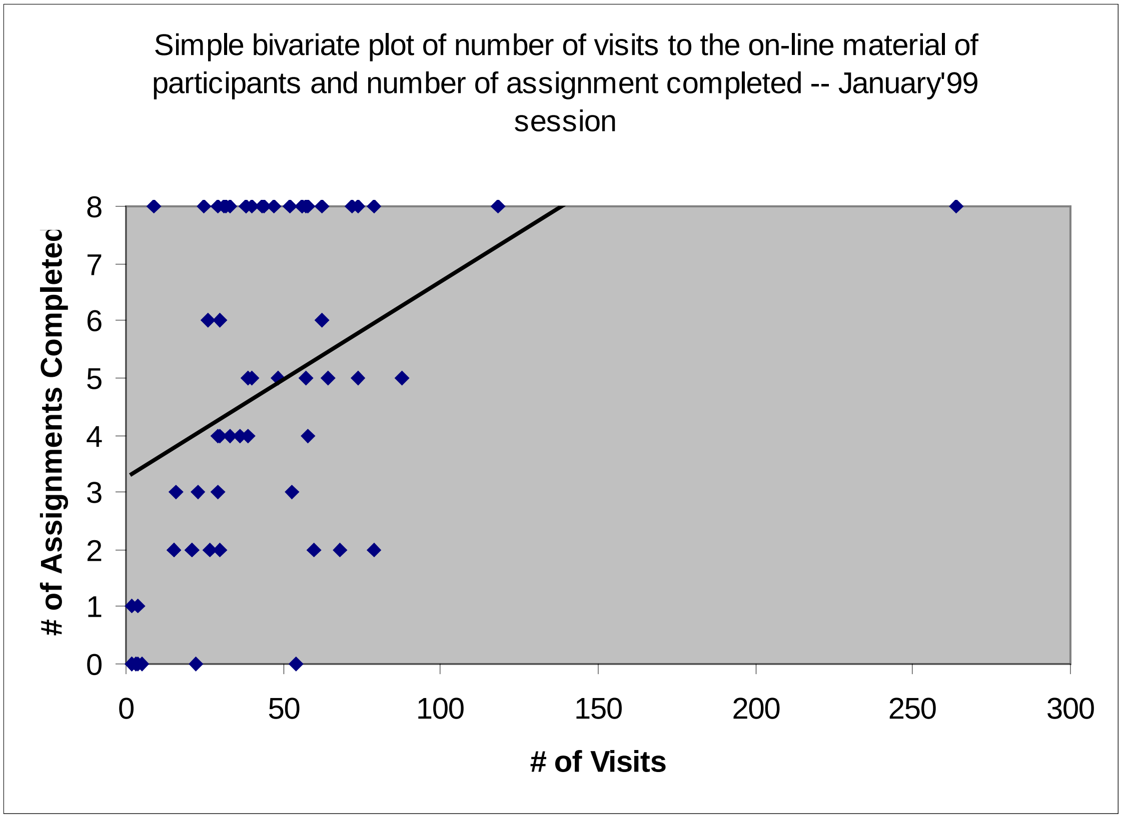


Figure 27. Scatter Plot or Simple Bivariate Plot of Number of Visits to the Learning Material and Number of Assignments Completed. The Bold Line Represents the Regression Line (or Line of Best Fit).

<u>Correlation analysis between number of visits and total number of times using the KnowBots (January-99 session)</u>

Employing the same guideline, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value r = 0.258 is a positive number that is greater than the tabled critical one-tailed values $r_{.05}$ = .211 and a little greater than the tabled critical two-tailed values $r_{.05}$ = .250. It is not, however, supported at the .01 level of both one-tailed and two-tailed critical values, since r = 0.258 is less than .295 and .325 respectively.

Hence, it can be considered that the number of visits to the learning material and the total number of times using the KnowBots have weak positive correlation. By employing Fisher's transformation to determine the 95% confidence interval for the computed value $r = 0.258$, the true correlation value ρ can be written as follows: $0.009 \leq \rho \leq 0.479$. The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also support this statement as presented below:

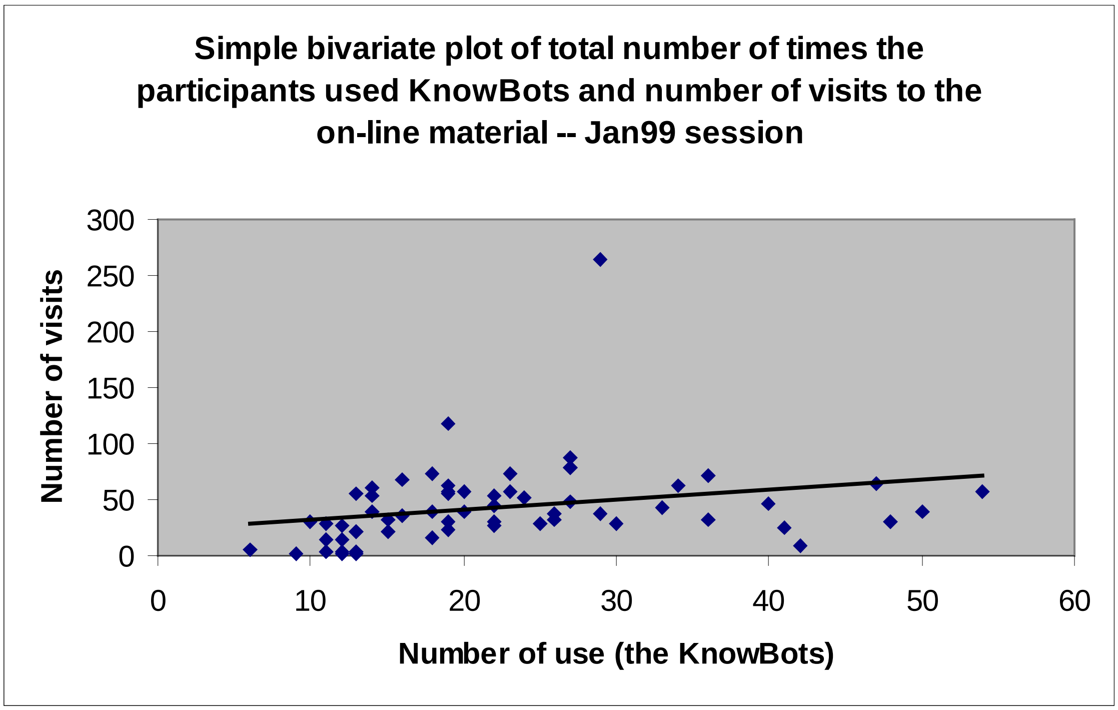


Figure 28. Scatter Plot or Simple Bivariate Plot of Number of Visits to the Learning Material and Total Number of Times Using the KnowBots. Note that the Outlier Resulted from a Participant Who Spent Significantly More Time on the Workshop than the Others.

Correlation analysis between number of assignments completed and total number using the KnowBots (January-99 session)

Employing the same guideline, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value $r = 0.655$ is a positive number that is greater than all tabled critical values (critical one-tailed values $r_{.05} = .211$ and $r_{.01} = .295$, critical two-tailed values $r_{.05} = .250$ and $r_{.01} = .325$). Therefore, it can be considered that the number of visits to the learning material and the number of assignments completed have moderate positive correlation. By employing Fisher's transformation to determine the 95% confidence interval for the computed value $r = 0.655$, the true correlation value ρ can be written as follows: $0.484 \le \rho \le 0.777$. The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also support this statement as presented below:

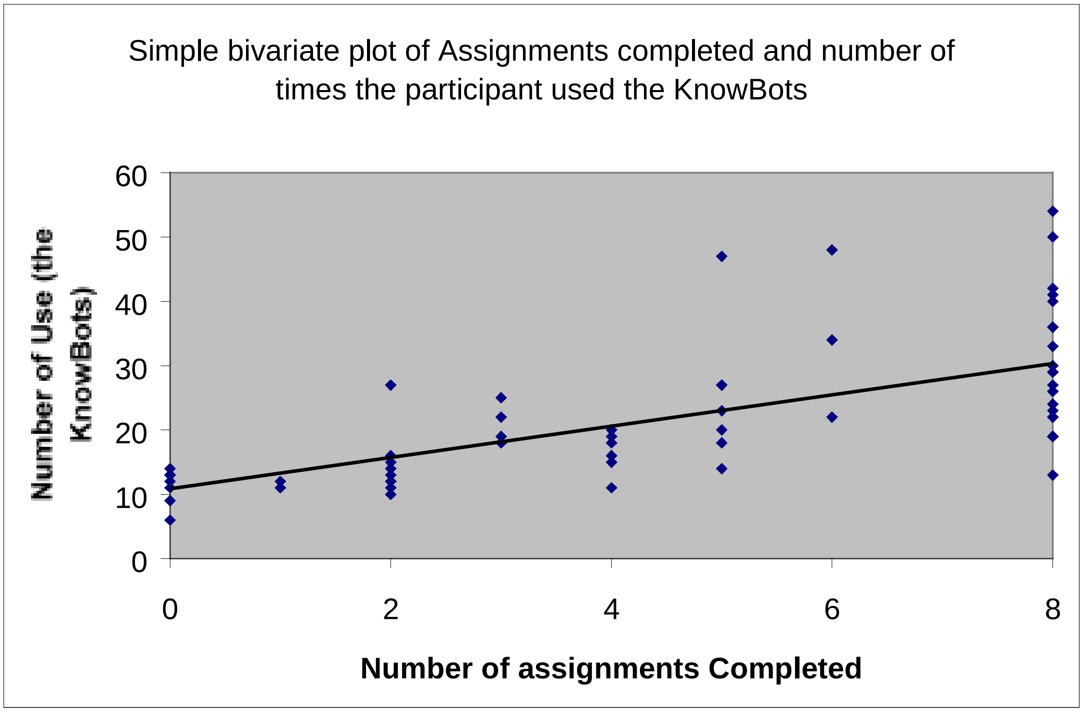


Figure 29. Scatter Plot or Simple Bivariate Plot of Number of Assignments Completed and Total Number of Times Using the KnowBots.

Another correlation test was performed on the same data of the September-98 session. From data in table B-2 of Appendix B, the correlation matrix result of the September-98 session is presented below:

Correlations (Pearson)

September-98 session

	Number of Visits	Number of Assignments Completed
Number of Assignments Completed	0.572 0.000	
Number of Times Using KnowBots	0.574 0.000	0.734 0.000

Cell Contents: Correlation (r, correlation coefficient)
P-Value

Figure 30. Correlation Matrix of Number of Times Using the KnowBots, Number of Assignments Completed, and Number of Visits to the Learning Material of Participants in September-98 Workshop Session.

To determine the Critical Values for Pearson, Table A16 from Appendix A was used where degrees of freedom, DF = 92. The tabled critical two-tailed r-values at the .05 and .01 levels of significance are $r_{.05} = .203$ and $r_{.01} = .264$, and the tabled critical one-tailed r-values at the .05 and .01 levels of significance are $r_{.05} = .171$ and $r_{.01} = .240$.

<u>Correlation analysis between number of visits and number of assignments completed (September-98 session)</u>

Employing the same guideline, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value $r = 0.572$ is a positive number that is greater than all tabled critical values (critical one-tailed values $r_{.05} = .171$ and $r_{.01} = .240$, critical two-tailed values $r_{.05} = .203$ and $r_{.01} = .264$). Therefore, it can be considered that the number of visits to the learning material and the number of assignments completed have <u>moderate positive correlation</u>. By employing Fisher's transformation to determine the 95% confidence interval for the computed value $r = 0.572$, the true correlation value ρ can be written as follows: $0.418 \leq \rho \leq 0.693$.

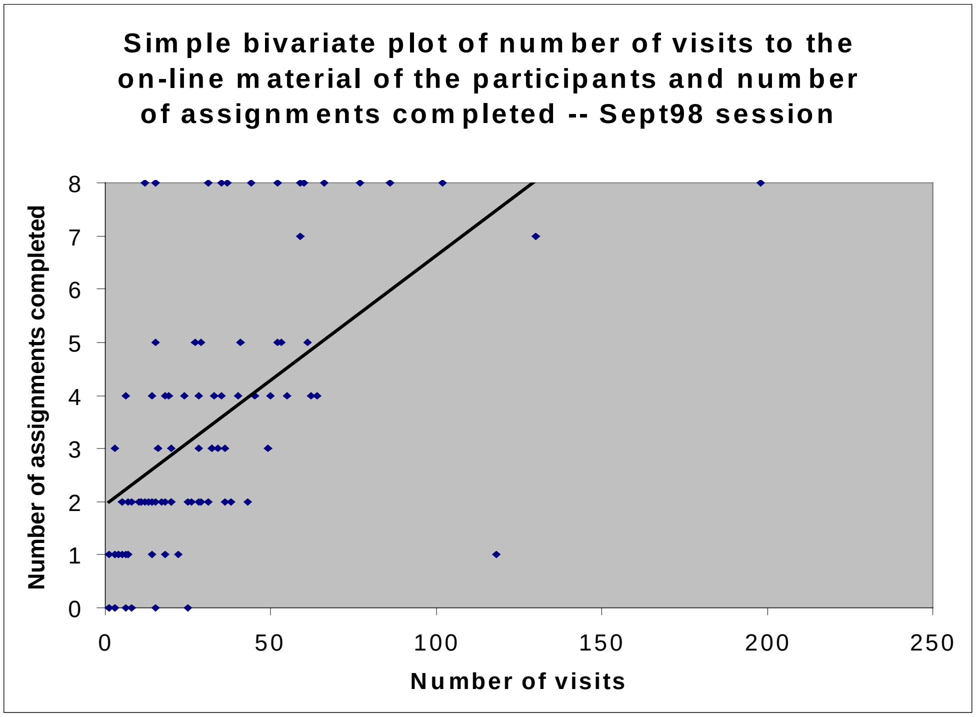


Figure 31. Scatter Plot or Simple Bivariate Plot of Number of Visits to the Learning Material and Number of Assignments Completed (September-98 Session).

The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also supports this statement as presented in Figure 31.

<u>Correlation analysis between number of visits and total number of times using the KnowBots (September-98 session)</u>

Employing the same guideline, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value $r = 0.574$ is a positive number that is greater than all tabled critical values (critical one-tailed values $r_{.05} = .171$ and $r_{.01} = .240$, critical two-tailed values $r_{.05} = .203$ and $r_{.01} = .264$). Hence, it can be considered that the number of visits to the learning material and the total number of times using the KnowBots of this specific session have <u>moderate positive correlation.</u> By employing Fisher's transformation to determine the 95% confidence interval for the computed value $r = 0.574$, the true correlation value ρ can be written as follows: $0.420 \leq \rho \leq 0.695$. The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also supports this statement as presented below:

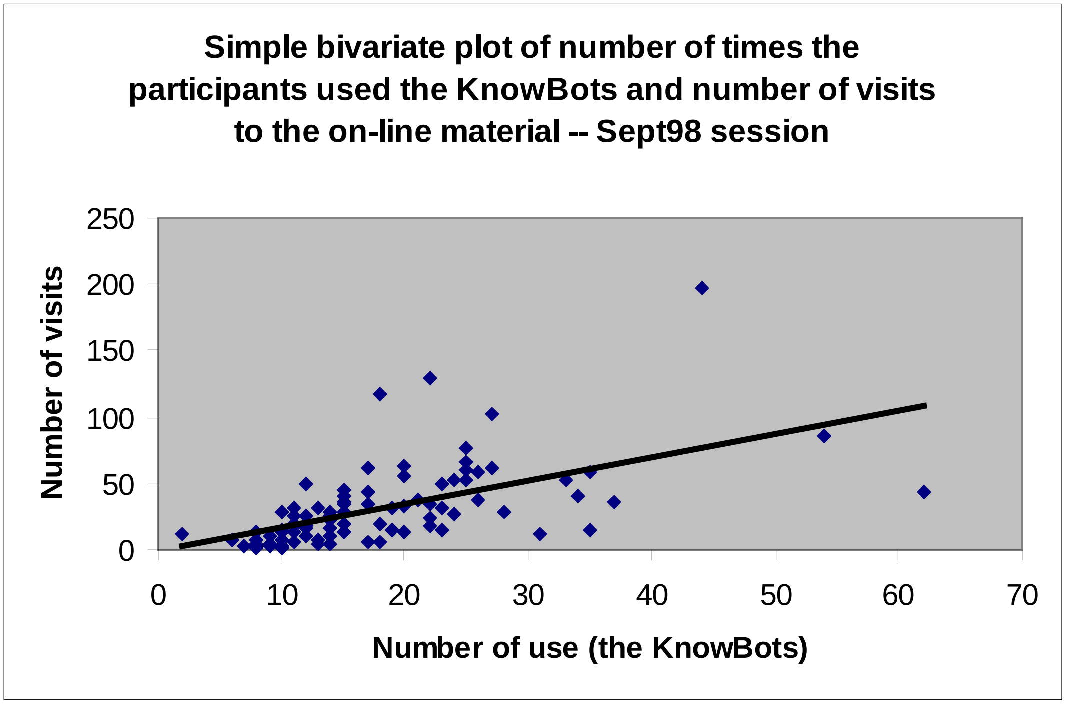


Figure 32. Scatter Plot or Simple Bivariate Plot of Number of Visits to the Learning Material and Total Number of Times Using the KnowBots (Septmber-98 Session).

<u>Correlation analysis between number of assignments completed and total number using the KnowBots (September-98 session)</u>

Employing the same guideline, the directional alternative hypothesis is supported at both the .05 and .01 levels, since the computed value r = 0.734 is a positive number that is greater than all tabled critical values (critical one-tailed values $r_{.05}$ = .171 and $r_{.01}$ = .240, critical two-tailed values $r_{.05}$ = .203 and $r_{.01}$ = .264). Therefore, the number of visits to the learning material and the number of assignments completed of this specific session (September-98) have <u>moderate positive correlation</u>. By employing Fisher's transformation to determine the 95% confidence interval for the computed value r = 0. 0.734, the true correlation value ρ can be written as follows: $0.625 \leq \rho \leq 0.8912$. The simple bivariate plot (or two-variable plot, or scatterplot) of these two variables also supports this statement as presented below:

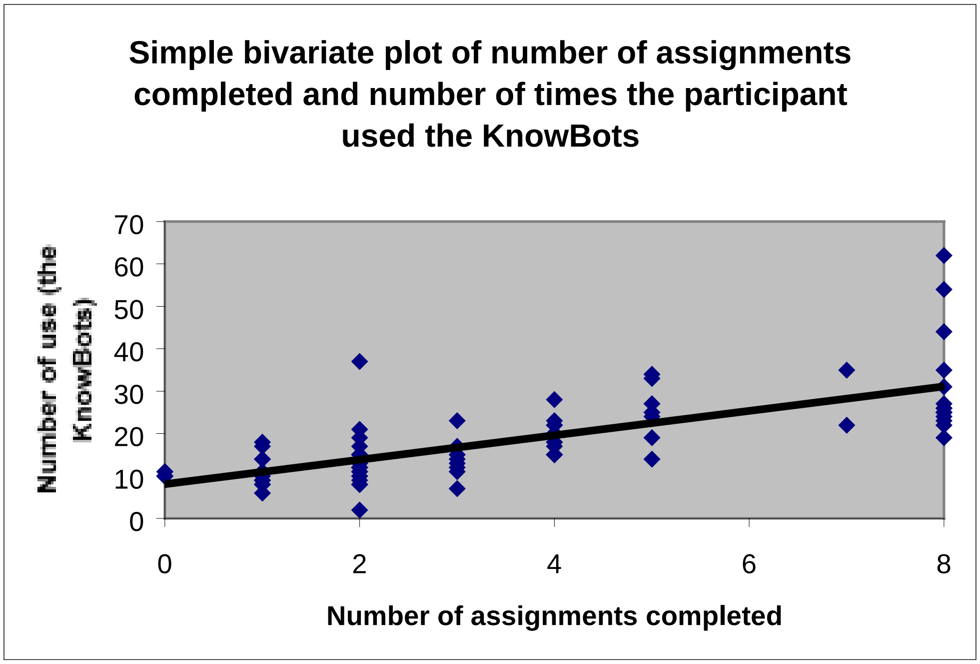


Figure 33. Scatter plot or Simple Bivariate Plot of Number of Assignments Completed and Total Number of Times Using the KnowBots (September-98 Session).

Hence, correlation analyses of data obtained from both sessions can be summarized in Table 11 below:

Table 11 Correlation Analysis Summary

	Correlation level between number of visits to the learning material and number of assignments the participant completed	**Correlation level between number of visits to the learning material and number of times the participant used the KnowBots**	**Correlation level between number of assignments the participant completed and number of times the participant used the KnowBots**
September-98 session	*r* = 0.572, $0.418 \leq \rho \leq 0.693$ Moderate positive	*r* = 0.574, $0.420 \leq \rho \leq 0.695$ Moderate positive	*r* = 0.734, $0.625 \leq \rho \leq 0.891$ Moderate positive
January-99 session	*r* = 0.432, $0.205 \leq \rho \leq 0.616$ Moderate positive	*r* = 0.258, $0.009 \leq \rho \leq 0.479$ Weak positive	*r* = 0.655, $0.484 \leq \rho \leq 0.777$ Moderate positive

To determine whether the difference between the two correlations is statistically significant, two correlation coefficients of same pair of variables but from different sessions of the workshop are computed (e.g., correlation coefficient of number of visits to the learning material and number of assignments completed by the participants from the September-98 session, r_1 = 0.572, and from the January-99 session, r_2 = 0.432) as follows:

$$z = \frac{z_{r1} - z_{r2}}{\sqrt{(1 / (n_1 - 3)) + (1 / (n_2 - 3))}}$$

Where: z_{r1} represents the Fisher transformed value of the computed value of r_1 for the September-98 session

z_{r2} represents the Fisher transformed value of the computed value of r_1 for the January-99 session

n_1 and n_2 are respectively the number of participants in the September-98 and the January-99 session

The null hypothesis is that in the underlying populations represented by two sampled, the correlation between the two variables is equal: H_0: $\rho_1 = \rho_2$. The alternative hypothesis is that in the underlying populations represented by two samples, the correlation between the two variables is not equal: H_1: $\rho_1 \neq \rho_{2.}$

In order to reject the null hypothesis, the obtained absolute value of z must be equal or greater than the tabled critical two-tailed value at the pre-specified level of significance ($z_{.05}$ = 1.96 and $z_{.01}$ = 2.58).

Table 12 below summarizes the resulting data from Table 11 with the computed z values.

Table 12 Correlation Analysis Summary with the Computed z Values

	Correlation level between number of visits to the learning material and number of assignments the participant completed	**Correlation level between number of visits to the learning material and number of times the participant used the KnowBots**	**Correlation level between number of assignments the participant completed and number of times the participant used the KnowBots**
September-98 session	$r = 0.572$, $0.418 \le \rho \le 0.693$ Moderate positive	$r = 0.574$, $0.420 \le \rho \le 0.695$ Moderate positive	$r = 0.734$, $0.625 \le \rho \le 0.891$ Moderate positive
January-99 session	$r = 0.432$, $0.205 \le \rho \le 0.616$ Moderate positive	$r = 0.258$, $0.009 \le \rho \le 0.479$ Weak positive	$r = 0.655$, $0.484 \le \rho \le 0.777$ Moderate positive
z value	1.124 (Accept Null Hypothesis)	2.333 (Reject Null Hypothesis)	0.921 (Accept Null Hypothesis)

The obtained z value between the correlation coefficients of number of visits to the learning material and number of assignments completed by the participants from the September-98 and the January-99 session is 1.124, which is less than the tabled critical two-tailed values $z_{.05} = 1.96$ and $z_{.01} = 2.58$. Hence, the alternative hypothesis H_1: $\rho_1 \neq \rho_2$ is not supported at either the .05 or .01 level. Thus, we accept the null hypothesis that there is an equal correlation between the two variables in each session. This confirms that the correlation levels of these two variables are the same (moderate positive correlation).

The obtained z value between the correlation coefficients of number of visits to the learning material and number of using the KnowBots by the participants from the September-98 and the January-99 session is 2.333, which is less than the tabled critical value at .01 level $z_{.01} = 2.58$. It is, however, greater than the tabled critical value at .05 level $z_{.05} = 1.96$. Hence, the alternative hypothesis H_1: $\rho_1 \neq \rho_2$ is supported at the .05 level. Thus, at 95% confidence interval, the correlation levels of these two variables must not be the same. This confirms that the initial conclusion on correlation levels of these two variables is correct -- for the September-98 session the correlation level is moderate positive correlation and for the January-99 session the correlation level is weak positive correlation.

The obtained z value between the correlation coefficients of number of assignments completed and number of times using the KnowBots by the participants from the September-98 and the January-99 session is 0.921, which is less than the tabled critical two-tailed values $z_{.05}$ =

1.96 and $z_{.01} = 2.58$. Hence, the alternative hypothesis H_1: $\rho_1 \neq \rho_2$ is not supported at either the .05 or .01 level. Thus, we accept the null hypothesis that there is an equal correlation between the two variables in each session. This confirms that the correlation levels of these two variables are the same (moderate positive correlation).

In order to further investigate a possible correlation between the number of times the participant used KnowBots for an assignment and the completion of that assignment, a correlation analysis was performed using the data from Table C-1 and C-2 from Appendix C. Results from the correlation analysis are presented in Table 13 and 14 below.

Table 13 Correlation Analysis of Table C-1 (Data on Number of Times Using Each Checker and Completion Status of Each Assignment -- January-99 Session)

	Correlation (r-value)	**Correlation Level**
Checker1 and completion of assignment 1	0.133	No correlation
Checker2 and completion of assignment 2	-0.182	Inverse or indirect relationship
Checker3 and completion of assignment 3	0.498	Moderate positive (direct relationship)
Checker4 and completion of assignment 4	0.231	Weak positive (weak direct relationship)
Checker5 and completion of assignment 5	0.572	Moderate positive
Checker6 and completion of assignment 6	0.836	Strong positive
Checker7 and completion of assignment 7	0.795	Strong positive
Checker8 and completion of assignment 8	0.812	Strong positive

Table 14 Correlation Analysis of Table C-2 (Data on Number of Times Using Each Checker and Completion Status of Each Assignment -- September-98 Session)

	Correlation (r-value)	**Decision (or correlation level)**
Checker1 and completion of assignment 1	-0.208	Inverse or indirect relationship
Checker2 and completion of assignment 2	0.313	Moderate positive (direct relationship)
Checker3 and completion of assignment 3	0.563	Moderate positive
Checker4 and completion of assignment 4	0.542	Moderate positive
Checker5 and completion of assignment 5	0.488	Moderate positive
Checker6 and completion of assignment 6	0.823	Strong positive
Checker7 and completion of assignment 7	0.640	Strong positive
Checker8 and completion of assignment 8	0.886	Strong positive

Table C-1 (January-99 session) and C-2 (September-98 session) present data on the number of times the participant used each Checker (e.g., Checker 1 means KnowBots for Assignment #1) and the completion of each assignment (1 = complete, 0 = incomplete) of the January-99 session.

To rationalize the data results from Table 13 and 14: The correlation values of Checker1 vs. Assignment #1 Completion and Checker2 vs. Assignment #2 Completion varied between an indirect relationship to a weak direct relationship. A possible cause could be that these two assignments were fairly simple. Assignment #1 requires the participant post two messages in the conferencing system and Assignment #2 requires the participant to post a minimum of three reviews of on-line courses in the conferencing system (See Appendix G for the detail on Requirements for Completion of the Assignments). So, due to the simplicity of Assignment #1 and #2, the participant may not have needed as much of assistance from Checker1 and Checker2. On the other hand, Assignment #3, #4, and #5 were more complex than the first two assignments. The level of difficulty of the required tasks for these assignments ranged from creating a simple personal homepage using basic HTML to creating a course homepage using advanced features of FrontPage. The results from correlation support that there is positive association between the number of times the participant used these Checkers and the completion of these assignments. For Assignment #6, #7, and #8, participants were required to use the KnowBots in order to prompt the workshop facilitator to check the assignments, which could explain the strong positive correlation for these assignments.

Alternative Hypotheses

Results on completion rates of all three sessions of the ALN workshop are presented below:

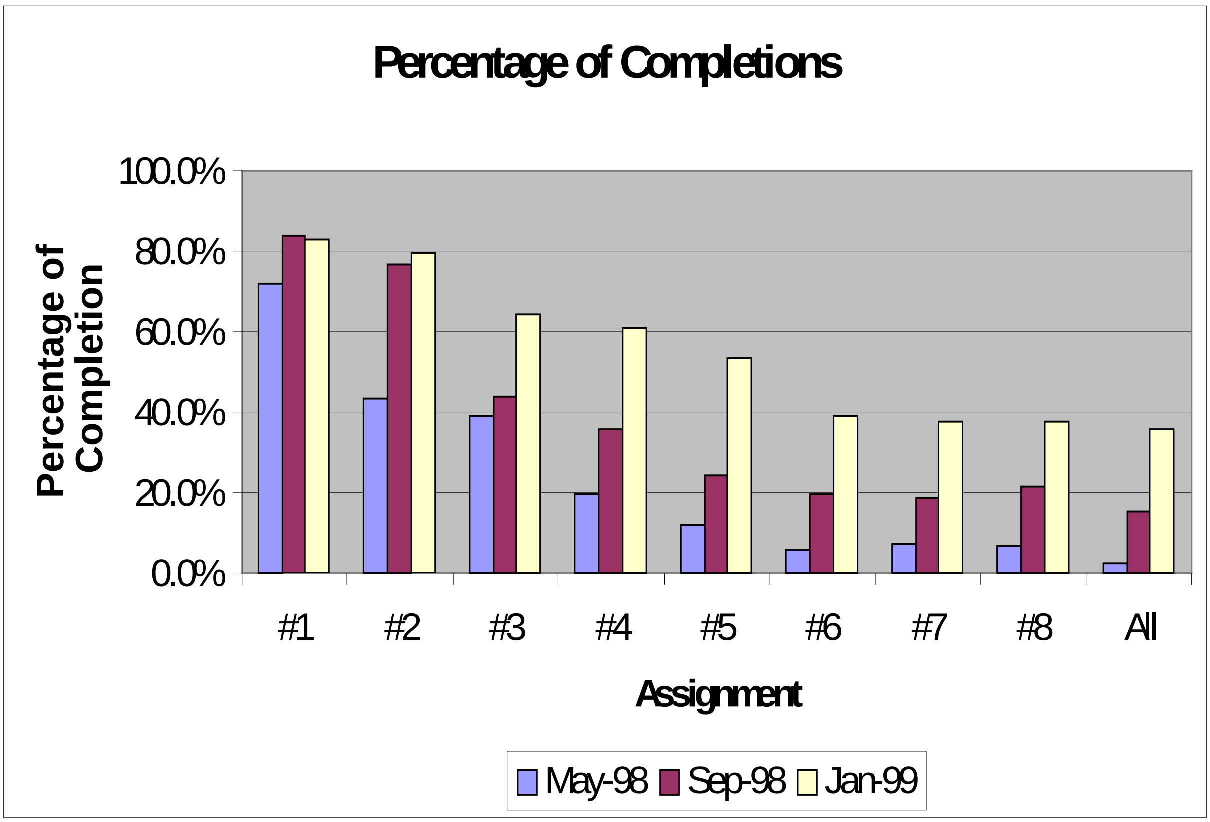


Figure 34. Percentage of Completions, by Assignment and Overall of Three Sessions of the ALN Workshop

Figure 34 shows that the percentages of completion of the last two sessions of the workshop (Sept-98 and Jan-99) were higher than the percentage of completion of May-98 session. As hypothesized, there would be a positive association between the use of KnowBots and the higher completion rates of the later sessions. However, there are a number of issues that might be factors affecting the higher completion rates in the later sessions. Therefore, a number of alternative hypotheses may be posted in attempting to explain why the decay rate of the completion decreases, other than the use of KnowBots:

1. One facilitator, Jason, was specifically assigned and responsible for facilitating the workshop full-time for the January-99 session.
2. There were fewer students in the last two sessions.
3. The experience of learners in the later sessions was higher.
4. KnowBots were emphasized more and available earlier in the January-99 session.

Alternative hypothesis #1: One facilitator (Jason) was specifically assigned and responsible for facilitating the workshop full-time for the January-99 session. The graphic below shows the increase in facilitation activities, in particular Jason, in the January-99 session of the workshop.

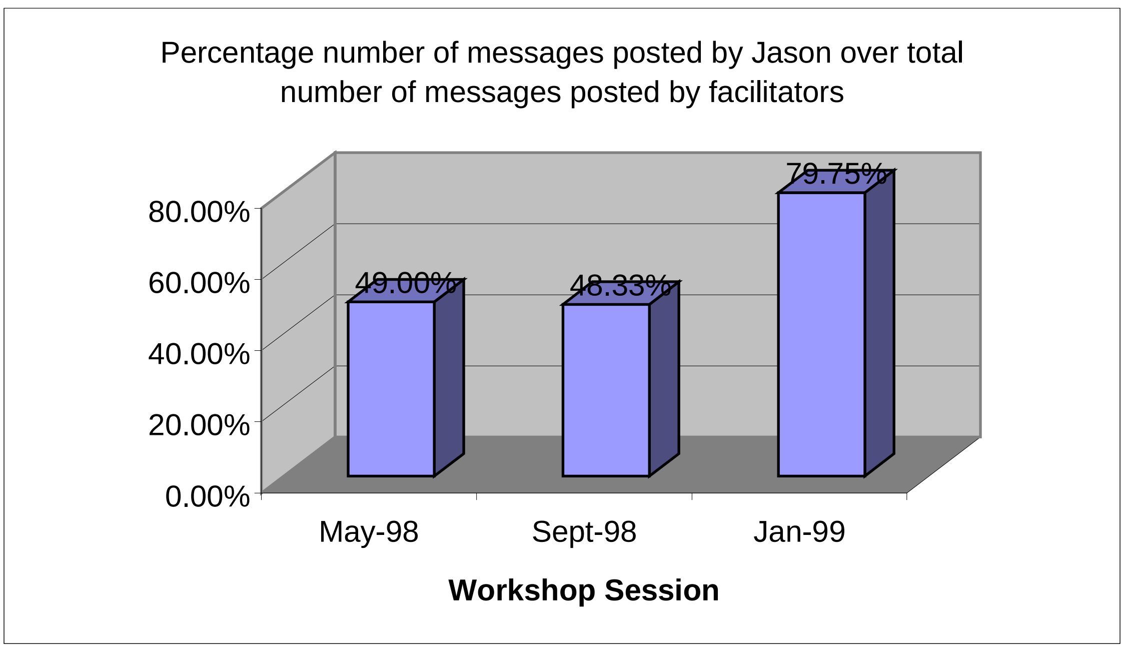


Figure 35. Percentage of Number of Messages Posted by Jason Over the Total Number of Messages Posted by the Facilitators of Each Session of the Workshop

Therefore, this change in facilitation could possibly be an effect other than the use of KnowBots that caused the highest percentage of completion in the January-99 session.

Alternative hypothesis #2: There were fewer students in the last two sessions. There were 98 participants in the September-98 session, and 64 participants in the January-99 session compared to 220 participants in May-98 session.

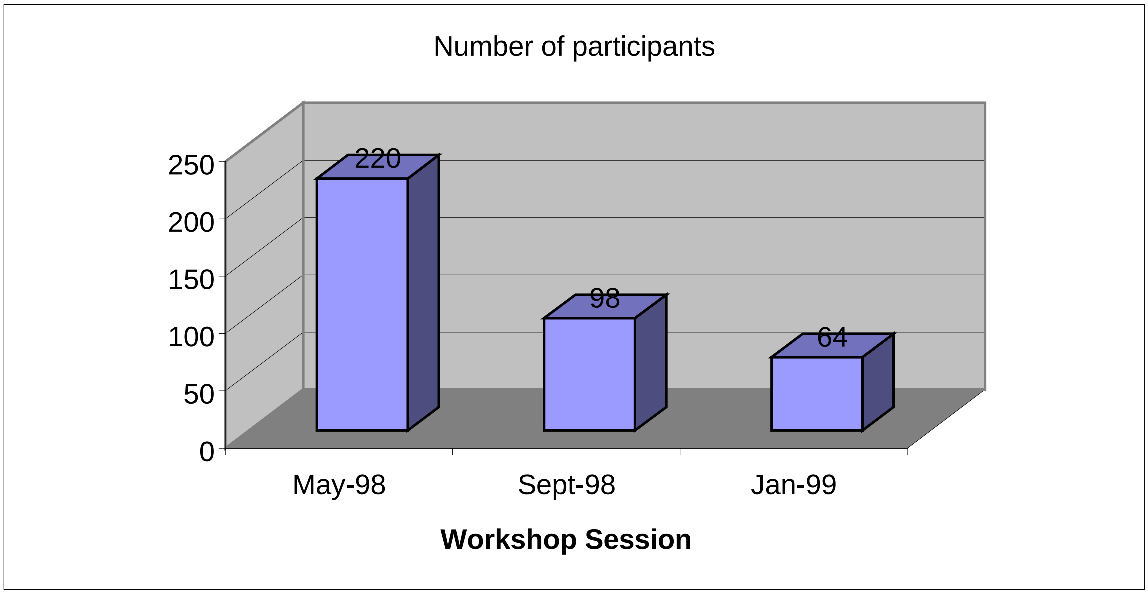


Figure 36. Number of Participants of Each Session of the Workshop

It is possible that the smaller number of participants might be a factor affecting the higher completion rates in later sessions of the workshop. The workshop facilitators might have been able to do a better job of facilitating a fewer number of participants.

Alternative hypothesis #3: Experience of learners in the later sessions was higher.

The primary weaknesses of the study are in the potential for selection of treatment and for problems that result from the Internet-related knowledge of participants in the later sessions possibly being higher. At this time, there is no evidence provided to either support or reject this alternative hypothesis. However, the major purpose of this study was to investigate possible effects of the use of KnowBots on the workshops. Since the study spanned a relatively short period of time, it was assumed that there is no difference in participant knowledge between the groups. In addition, some recommendations have been included in the Discussions and Conclusions of this study in order to improve the validity of future studies.

Alternative hypothesis #5: KnowBots were gradually more stable during the September-98 and January-99 sessions and emphasized more and available earlier in the Jan-99 session.

When the KnowBots system was first introduced to the workshop learning environment in the September-98 session, it at the time was not quite mature due to the development of the KnowBots progressing along with the September-98 workshop. However, during the January-99 session, KnowBots were used again in a much more improved and matured state than the first time. Hence, this might be a factor affecting the higher completion rate in the January-99 session than in the September-98 session.

To rationalize whether KnowBots for the January-99 session might be more mature than KnowBots for the September-98 session, t-test analysis was performed on the number of assignments completed by the participants from January-99 and September-98 sessions. It is assumed that if KnowBots for the January-99 session were more mature that the other session, the mean of assignment completions would be significant different between these two sessions.

The result from the t-test analysis is presented in the figure below:

Two Sample T-Test and Confidence Interval

Two sample T for Number of Assignments Completed in January-99 session vs. Number of Assignments Completed in September-98 session

Number of Assignments Completed by Participants	N	Mean	StDev	SE Mean
January-99 session	64	4.58	3.04	0.38
September-98 session	98	3.08	2.61	0.25

95% Confidence Interval for $\mu_{January-99} = \mu_{September-98}$: (0.59, 2.40)

T-Test $\mu_{January-99} = \mu_{September-98}$ (and not equal): T = 3.27, P = 0.0014, DF = 117

$\mu_{January-99}$: the mean of number of assignments completed by participants in January-99 session, $\mu_{September-98}$: the mean of number of assignments completed by participants in September-98 session

Figure 37. t-test Analysis between Number of Assignments Completed by Participants from the September-98 Session and the January-99 Session

Using the same guideline for evaluating the t-value, the obtained t-value $t = 3.27$ is greater than the critical values ($p<0.01$). Therefore, this outcome is consistent with the prediction that the group from the January-99 session exhibited a higher number of assignment completions than the September-98 group.

Survey Result Analysis

The following section presents results and analysis of data obtained through the use of a questionnaire. The analysis provides evidence to understand how the use of KnowBots affected the learners psychologically, as well as how effectively the KnowBots performed the assigned functions.

Participants from all three sessions were requested by email to fill out the survey questionnaire through the web. There were 91 responses from the total number of 220 participants in May-98 session, which is equal to 41.36% response. For September-98 session, there were 49 responses out of 98 participants, which is equal to 50% response. For January-99 session, the responses were 32 or 50% from the total number of 64 participants. A copy of the questionnaire survey can be viewed in Appendix E.

Usability Ratings (Question 4.9-4.11)

Participants from September-98 and January-99 sessions, who experienced using the KnowBots, were asked in the questionnaire to rate on the Likert scales (where scale 5 = very high, excellent or very much, 4 = good, 3 = adequate, 2 = fair, and 1 = very low, very poor or not at all) of usability of KnowBots' features below:

- Email notification and reminder of the assignment
- On-demand Checkers
- Report and direction from the Checkers

Results from the survey were summarized in Table 15:

Table 15 Survey results: Usability Ratings

Ratings	Email reminder		On-demand Checkers		Report	
	Sept98	Jan99	Sept98	Jan99	Sept98	Jan99
4-5 (+)	69%	81%	74%	72%	59%	56%
3	10%	6%	14%	13%	14%	28%
2-1 (-)	12%	3%	4%	6%	18%	6%
Blank	8%	9%	8%	9%	8%	9%

It was clear that the majority of both groups felt the same way that email and reminder features of the KnowBots were very useful (69% from September-98 session and 81% from January-99 session).

In addition, it was quite consistent that both groups of participants felt strongly positive on the usefulness of the on-demand KnowBots (74% from September-98 session and 72% from January-99 session). From the data shown above, the percentage of the usability of "Report" feature shows fairly lower than the other two features -- "Email Reminder" and "On-demand Checkers". One possible reason might be that the report and directions given by the KnowBots might not be clear enough.

Correlation analyses between each feature are also strongly positive. Table 16 below presents correlation values of the features of the KnowBots:

Table 16 Correlation Analysis of Usability Ratings

	Email reminder - On-demand Checkers	Email reminder - Report	On-demand KnowBots – Report
Correlation values: September-98 session	0.916	0.793	0.851
Correlation values: January-99 session	0.880	0.729	0.788

By the results from the correlation analysis above, it may be concluded that the participants felt quite the same way toward all the features of the KnowBots.

Motivation (Question #4.2, 4.14-4.17)

Participants from both treated groups (September-98 and January-99) were asked their opinion about how well KnowBots helped to motivate them to complete the assignment in Question #4.2. The purpose of this question was to investigate whether the use of KnowBots affected the motivation to complete the workshop. Data from the survey is presented below. Again, the questionnaire provided the same Likert scales for the participant.

Table 17 Survey Result: Motivation

Ratings	**Sept98**	**Jan99**
4-5 (+)	60%	63%
3	12%	22%
2-1 (-)	22%	6%
Blank	6%	9%

The results from the table showed the percentage of positive feeling about the KnowBots helped motivate the learners to complete the workshop were increased slightly, from 60% to 63%, from September-98 to the January-99 session. It is worth noting that the number of negative responses toward the question of whether the use of KnowBots helped motivate to complete the workshop decreased (from 22% to 6%).

In addition to Question #4.2, additional questions (Question #4.14 - #4.16) were provided to ask the participants which features of the KnowBots helped improve their motivation to complete the assignment. These features are:

- Encouraging message sent to the participant by email
- The explicit directions in the report after checking the participant's assignment
- Reminding the participant to complete the assignment before the due dates

The results from the survey are summarized in the table below:

Table 18 Survey Results: Features of KnowBots that Motivated

Ratings	**Encouraging message**		**Explicit direction**		**Reminder**	
	Sept98	**Jan99**	**Sept98**	**Jan99**	**Sept98**	**Jan99**
4-5 (+)	55%	62%	56%	66%	68%	69%
3	16%	22%	20%	19%	10%	19%
2-1 (-)	22%	3%	14%	3%	14%	3%
Blank	6%	13%	10%	13%	8%	13%

Data shown above indicate that the number of those who felt positive about the encouraging email message generated by the KnowBots as a motivational tool to help them to complete the assignment were up between the two sessions (from 55% to 62%). It also indicates that the number of those who thought of explicit direction given by the KnowBots as a motivational tool increased from 56% for the September-98 session to 66% for the Janauary-99 session. The majority of participants from both groups (68% of September-98 and 69% of January-99) felt the same way, that the reminder feature of KnowBots was a motivational tool that helped participants to complete their assignments.

The results from correlation analysis of all features listed above that helped motivate the participants to complete the assignments were quite strongly positive as shown in Table 19. The implication would be that participants felt fairly consistently that the features of the KnowBots affected their motivation to completing the assignments.

Table 19 shows the correlation values of opinions of the participants toward the features affecting motivation.

Table 19 Correlation Analysis of Features that Motivated

	Correlation value of Encouraging message and Explicit direction features	**Correlation value of Encouraging message and Reminder features**	**Correlation value of Explicit direction and Reminder features**
September-98 session	0.612	0.628	0.660
January-99 session	0.810	0.899	0.823

It is worth noting that all correlation values of the January-99 session have much higher values than the correlation values of the September-98 session. The higher correlation values of January-99 session as compared to those of the September-98 session might imply that the KnowBots for the January-99 session were more mature and more consistent than the KnowBots for the September-98 session.

Effectiveness of Instruction (Question #4.4)

In order to investigate the effectiveness of the instruction given by the KnowBots, the participants from both treated groups were asked in the survey questionnaire whether the instructions were effective. Results from the questionnaire survey on this issue were summarized below:

Table 20 presents the survey results on the effectiveness of the instructions given by the KnowBots:

Table 20 Survey Results: Effectiveness of Instruction

Ratings	**Sept98**	**Jan99**
4-5 (+)	59%	57%
3	18%	31%
2-1 (-)	16%	3%
Blank	6%	9%

59% of participants in September-98 session felt positive that the instructions given by KnowBots were effective. On the other hand, almost the same percentage in the January-99 session, 57%, felt the same way. However, a positive sign is that the number of those who felt negative from September-98 to January-99 session decreased. By looking at the percentage of those who disagreed with the effectiveness of the instruction given by the KnowBots in September-98 session, this could also be evidence that the KnowBots of September-98 session were less mature and less consistent than that of January-99 session. Similarly, the number who felt that the instructions given by the KnowBots of the January-99 session were effective enough (on scale = 3) increased between two sessions.

Confidence of Participants (Question #4.6)

The participants from both treated groups were asked for their opinion as to whether KnowBots helped improve their confidence to complete the workshop. The results are summarized in the table below:

Table 21 presents survey results on whether the KnowBots affected the confidence of participants to complete the workshop.

Table 21 Survey Results: Confidence of Participants

Ratings	**Sept98**	**Jan99**
4-5 (+)	53%	51%
3	24%	22%
2-1 (-)	16%	19%
Blank	6%	9%

The data shown above indicate that there is not much difference between the two sessions in the number of participant who agreed that the KnowBots helped improved their confidence of the learners to complete the workshop.

Consistency with the Instruction (Question #4.5)

Participants from both treated groups were asked in the survey questionnaire how consistent the KnowBots instructions were with the instruction given in the workshop. The results are presented in Table 22:

Table 22 Survey Results: Consistency with Instruction

Ratings	**Sept98**	**Jan99**
4-5 (+)	57%	62%
3	18%	19%
2-1 (-)	18%	9%
Blank	6%	9%

Notice that the number who felt positively about the consistency of the instruction given by the KnowBots was increased slightly from 57% to 62% between the two sessions. On the other hand, the number of those who disagreed decreased by half from 18% to 9% between two sessions. These results could again support the assumption that the KnowBots of the January-99 session were more consistent than of the September-98 session.

User's Satisfaction (Question #4.7)

To investigate the user's satisfaction with using the KnowBots, the participants from both treated groups were asked in the survey questionnaire how well the KnowBots helped them to complete the assignments. The results from the survey are presented below in Table 23:

Table 23 presents the resulting data from the survey questionnaire on how well the KnowBots helped the participant to complete the assignment.

Table 23 Survey Results: User's Satisfaction

Ratings	Sept98	Jan99
4-5 (+)	53%	53%
3	20%	31%
2-1 (-)	20%	6%
Blank	6%	9%

The figures above indicate that there is not much difference between the two sessions of the workshop in the percentage of those who strongly agreed that the KnowBots helped them complete the assignments. However, the percentage of participants who felt that the KnowBots performed tasks adequately (on scale = 3) to help the participants complete assignments increased between the two sessions.

Learning Behavior (Question #4.18)

In order to investigate whether the use of KnowBots affected the participants' learning behavior, the participants from both treated groups were asked in an open-ended question how the KnowBots changed the way they learn. The results from the survey are summarized below. Note that the number following each statement indicates the number of participants who expressed similar comments.

Table 24 Survey Results: Learning Behavior

Sept98:	**Jan99:**
- Confidence the KnowBots gave (3) - Use the on-demand KnowBots to verify the status then move on - Not at all (3) - Ability to keep trying (experiment) until pass - Help finish the assignment on-time - Own pace - Spent more time in order to satisfy the checkers - Provided high touch element to high tech methods of learning - Access to instant feedback helped improve my learning - Reminder of stuff that hadn't turned in yet + automated checker - Irritating and confusing, prefer more human touch	- Confidence the KnowBots gave (reassured me that I had indeed done the required work) (3) - Immediate gratification, prompted automated grading (2) - Tendency to only meet the KnowBots expectations (2) - It didn't, but made me aware of site and file organization or structure - It didn't - Helped me focus on where the assignment was not complete, saved me time to learn (4) - KnowBots are a psychological tool, should improve the language it used to communicate with participants - Fair assessment is always a plus

By looking at the survey results above, there were more positive comments that the use of KnowBots affected the way they learned in a positive way. Hence, this may reflect that the use of KnowBots helped improved the learner's satisfaction.

User-Interface (Question #4.19)

The participants from both groups were asked in an open-ended question in what way the KnowBots helped them to complete the assignment and the workshop. The results are summarized below:

Table 25 Survey Results: User-Interface

Sept98:	Jan99:
- Reminder (6) - Too many messages, then discouraging - Directions that KnowBots gave, helpful suggestions, and error reports (7) - Notify about the deadlines - Peace of mind (3) - Automation (3) - Help making the assignment requirement clear	- Reported the errors and suggested how to fix them (2) - Reassured me that I had completed the required tasks (9) - Reminder, sense of completeness - "Mommy nag" - Kept me informed of my current standing (2) - Explicit instruction (3) - Immediate feedback (2) - Helped me focus

Note that most of the comments are positive indicating that KnowBots are a learning-support tool that helped the participants to complete the workshop.

Time to Learn (Question #4.8)

The table below summarizes the results from the survey questionnaire. The participants from both treated groups were asked in the survey their opinion about whether the KnowBots helped reduce time to learn the workshop material.

Table 26 Survey Results: Time to Learn

Ratings	Sept98	Jan99
4-5 (+)	30%	22%
3	22%	22%
2-1 (-)	41%	43%
Blank	6%	13%

The survey results above were contrary with the initial expectation that the use of KnowBots helped reduce the time to learn the on-line material (41% from September-98 session and 43% from January-99 session.). However, to rationalize these results, this question might not have adequately reflected the participants' opinions as to what way the use of KnowBots helped improve their access to the learning material.

Access (Question #4.3)

Table 27 below summarized the data obtained from the questionnaire on whether the KnowBots helped improve access to the on-line material.

Table 27 Survey Results: Access

Ratings	Sept98	Jan99
4-5 (+)	43%	25%
3	18%	38%
2-1 (-)	30%	25%
Blank	8%	13%

The data above show that in September-98 session 43% of the participants felt positively that the KnowBots helped improve their access to the on-line material. However, 30% of the September-98 session felt negatively about that. Ironically, for the January-99 session, only 25% of participant felt strongly positive about this, and 38% (on scale=3) plus 25% (on scale 2-1) felt that the KnowBots did not really help improve the access to the on-line material.

Analysis on Time to learn (January-99) data:

To investigate further that what may have caused a higher number of negative feedback about the KnowBots helping reduce the learning time of the January-99 session (43%), a correlation test was performed on the learning time and access data. The results from this correlation test indicate that there is a very strong positive correlation between the opinion from the participants on learning time (Did KnowBots helped reduce the time needed to learn the material?) and access (Did KnowBots help improve access to the material?) (correlation value = 0.838). Hence, one possible reason might be that KnowBots of the January-99 session did not help improve access to the learning material. As a result, that caused the participants to spend more time learning the learning.

Analysis on Time to learn (September-99) data:

Again, the amount of negative feedback about the KnowBots helping reduce learning time for the September-98 session is also high (41%). To investigate what may have caused this high negative feedback number, another correlation test was employed. The results from this correlation test show that there is a strong positive correlation between the opinion of the participants in this category and the opinion of the participants on whether the KnowBots helped improved their confidence to complete the workshop (Confidence) (correlation value = 0.815). In addition, the correlation value between the opinions of the participants in this category and the opinions on how well the KnowBots helped to complete the assignments is also strong positive (Satisfaction) (correlation value = 0.860). Hence, it may be possible to conclude that those participants who felt dissatisfied about the use of KnowBots would strongly disagree that the KnowBots helped reduce learning time and that the KnowBots helped improve their confidence to complete the workshop. In other words, confusion from using the KnowBots caused the participants to feel that the use of KnowBots did not help improve their confidence to complete the workshop.

CHAPTER VI

DISCUSSION AND CONCLUSION

The central question in this study is to what extent intelligent software agents (KnowBots) can improve completion rate for on-line learning. The study finds positive associations between use of KnowBots and higher completion rates. This is an exploratory correlational study that used extant data rather than an experimental design. Because of the significant correlations, I can say that there is a basis for further investigation using experimental methods, but cannot say that KnowBots themselves cause[1] higher completion rates. Other possible factors in the higher completion rates of the later sessions are enumerated in the Results chapter.

Other than the higher completion rates in the later sessions of the workshop, the results of the study suggest that there is a good promise of applying this technology to on-line learning (Table 20 and 23). From the analysis of the survey results, the positive attitudes toward using the KnowBots were increased between the two groups (September-98 and January-99 sessions) that received help from KnowBots (Table 21, 22, and 23).

Hence, from the results of this study, it can be concluded that:

1. KnowBots are a motivational tool that helped workshop participants to complete the workshop.
2. KnowBots are a useful learning-support tool or tutor for an on-line learning environment.
3. To effectively use the KnowBots as a learning support tool for on-line learning, interaction with a human facilitator is still required.

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[1] It is important to note that correlation does not imply causation. A researcher is not justified in concluding that one variable causes the other variable if there is a strong correlation between two variables. Although it is possible that when a strong correlation exists one variable may, in fact, cause the other variable, the information employed in computing the Pearson product-moment correlation coefficient does not allow a researcher to draw such a conclusion (Sheskin, 1997, p. 541).

The Use of KnowBots and Facilitation Time

Results from the study indicate that the use of KnowBots did not help reduce workshop facilitation time when they were used for the first time in the September-98 session. There are two possible explanations for this outcome. First, KnowBots for the September-98 session were created along with the progress of the workshop. The evidence from the study indicated that KnowBots might not have been mature enough at that time. Second, there were no explicit directions or instructions of how to use the KnowBots provided for the participants of the September-98 session before the workshop started. Some participants of that particular session did not even know that they must use the KnowBots in order to verify the completion status of their assignments. Hence, that resulted in causing the participants some degree of confusion and frustration in completing the workshop (See comments in "Learning behavior", and "Analysis on Time-to-learn" in the Results chapter). According to the analysis of the use of KnowBots and facilitation time in the Results chapter, the number of messages posted by participants from the September-98 and January-99 sessions were much higher than the number of postings from the May-98 session. However, the results showed that the higher number of postings in the conferencing system by the participants corresponded well with the higher number of completion (Figure 23, 24 and 25). Evidently, as the assignments became more complex, the number of postings by the participants in the conferencing system to ask questions also tended to increase.

Despite the use of KnowBots resulting in an even longer facilitation time per participant, the positive sign of using the KnowBots was that the completion rate of the January-99 session was dramatically increased compared to completion rate of the May-98 session.

Many important questions remain unanswered. The KnowBots system was primarily created to automate the facilitator’s assignment checking tasks. It is important to examine the time the facilitators spent on these tasks. However in this study, I was unable to measure or examine the time facilitators would have spent on the assignment-checking tasks before and after using the KnowBots. Thus, it is important to evaluate the activities that the KnowBots performed on a human facilitator’s behalf. Perhaps, with this information one would be able to adequately design a way to carry out this measure in a future study.

KnowBots as a Motivational Tool

Due to the open environment nature of on-line learning and the overwhelming amount of information, the learners can easily lose track of the learning material. As a result, an on-line course typically has a low completion rate. Automated tools like KnowBots that help motivate learners to stay focused could well be fitted into this gap.

The results from this study tend to support the above statement. The results from the correlation analysis indicate a positive correlation between the number of times the participants used the KnowBots and the number assignments completed by the participants (Table 11 and 12).

Other psychological supports to the above statement would be the results from the survey analysis, specifically in the categories of "Motivation", "Learning Behavior", and "User Interface" in the Results chapter.

Results from the survey analysis on Motivation indicate that features of KnowBots such as encouraging email, immediate feedback, and reminders (Table 17, 18, and 19) helped motivate the participants to complete the workshop and the assignments. These features are a plus to the workshop when KnowBots are present in the learning environment. Specifically, the immediate feedback that the on-demand KnowBots provided after checking the participant's assignment helped motivate the learners to stay focused on completing the assignments. It provided explicit directions on how to fix the problems. This feature of KnowBots could be considered a push that helped improve the completion rate of the later sessions. Hence, this certainly helps support the conclusion that KnowBots are a motivational tool.

KnowBots as a Tutor

From the qualitative analysis of data obtained through the survey, a number of participants who experienced using the KnowBots system presented positive attitudes toward the use of KnowBots as a learning tutor. A possible reason might be the immediate feedback that KnowBots provided to the learners when they needed it. (See the "Learning Behavior" in the Results chapter). The immediate feedback helped the learners to quickly identify the problem and presented them with possible solutions. Other than reporting the assignment checking status, the immediate feedback also provided other assistance to where to find instruction in the learning material and where to seek further help. Therefore, KnowBots helped learners reduce time it took them to locate the problem and find a solution. Another implication of the use of the immediate feedback feature is that it allows participants to learn material at their own paces.

In conclusion, the results from the study showed that intelligent agents like KnowBots could significantly increase user comfort and productivity. The KnowBots system demonstrated that agent technology can successfully work in place of a human tutor to give personalized instruction.

The Use of KnowBots and User Satisfaction

While data collected from the two groups did not clearly distinguish the effect of the use of KnowBots from the user's satisfaction, the number of participants from the groups that received help from KnowBots presented higher positive attitudes toward the workshop overall than the group that did not. Table 28 and 29 below present the results from the survey question that asked the participants from three sessions to rate the overall quality of the workshop and whether the participant would recommend the workshop.

Question #3.1. How would you rate the overall quality of workshop?

Table 28 Survey Results: Overall Quality of the Workshop

	May-98 session (w/o KnowBots)	September-98 session (w/ KnowBots)	January-99 session (w/ KnowBots)
4-5 (+)	60%	66%	72%
3	32%	33%	19%
2-1 (-)	8%	2%	9%

Question #3.2. Would you recommend this workshop to a friend?

Table 29 Survey Results: Recommend to a Friend

	May-98 session (w/o KnowBots)	September-98 session (w/ KnowBots)	January-99 session (w/ KnowBots)
4-5 (+)	55%	65%	72%
3	33%	24%	19%
2-1 (-)	11%	10%	9%

A statistical difference was found from the one-tailed binomial test on the number of participants who rated 4 and 5 of the "Recommend to a friend" question between the participant groups of May-98 and January-99 session. This difference may suggest that the number of satisfied participants increased from the May-98 session to the January-99 session.

The graph below shows the number of participants who rated 4 and 5 on the Likert scales on the above two questions:

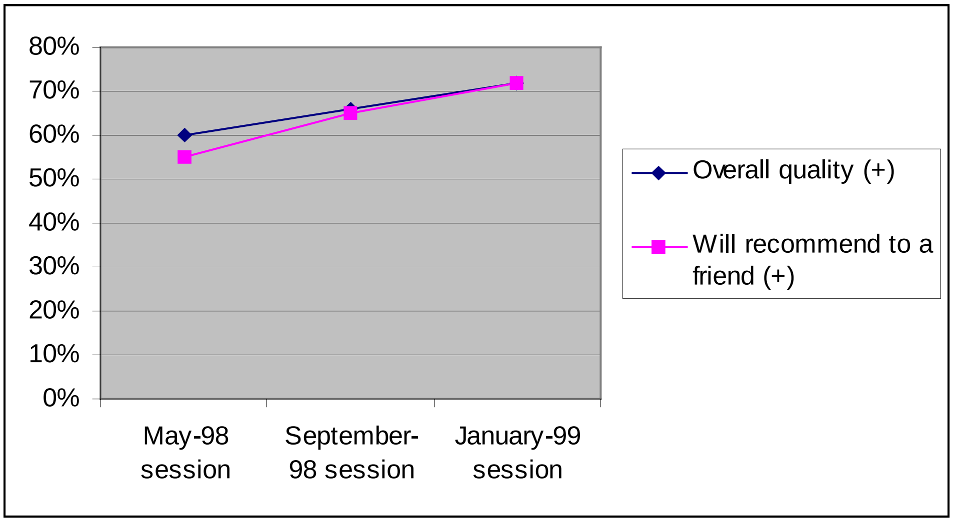

Figure 38. Percentage of Participants from Three Sessions that Felt Strongly Positive and Positive on the Overall Quality of the Workshop and Would Recommend It to a Friend

Despite that no statistical difference was found from the other proportional tests between the groups shown above, the figure indicates the possibility of an increasing trend in the number of who felt positively toward the workshop.

Interaction with Human Facilitators Is Still Required

One of the alternative hypotheses suggested that the high percentage of completion of the January-99 session might have resulted from one facilitator being specifically assigned to facilitate the workshop full time. Other than the data shown in Figure 33, there might not be other concrete evidence to either reject or support this alternative hypothesis at this time. However, the feedback from the participants and the survey results clearly showed that the learners preferred to have the option of being able to request help from a human facilitator whenever needed. As stated by Huhns and Singh (1997, p. 6), it would be inappropriate for the use of intelligent agents to eliminate the human interaction from an educational environment. Therefore, it can be concluded that to effectively adopt the KnowBots to the on-line learning environment, interaction with human facilitators is still required.

Conclusions

1. Adopting intelligent agents to an on-line learning environment like the ALN workshop presented in this study shows a very positive association with a higher completion rate. Despite there is no strong evidence that the use of KnowBots had a direct effect on the completion rate, the majority of the learners expressed positive attitudes toward using the KnowBots, specifically as a tool that helped motivate them to complete the workshop.
2. The question of whether the use of KnowBots helps reduce facilitation time remains unanswered. Despite that the study showed that there was no reduction in facilitation time during the September-98 and January-99 sessions, the measures used in this study were inadequate to lead to the answer. This is because the measures were unable to carry out (or include) the time the facilitator would have spent on checking the participants' assignments before and after KnowBots were being used.

3. Interaction with human facilitator should remain as an option for learners to request for further help when needed, even after adopting intelligent agents like KnowBots into the learning environment. Human interaction is still important for an educational environment.

KnowBots are an example of using intelligent agent techniques to automate the assignment checking tasks for a human facilitator. The KnowBots system demonstrates that adopting an intelligent agent to on-line learning is indeed feasible and provides a tool for allowing researchers to build intelligent agents for on-line learning.

Intelligent agents can be employed to shift on-line learning paradigms away from a traditional learning environment to concentrate instead on a user's individual needs. An on-line learning environment with intelligent agents moves student toward an apprenticeship, or learn-while-doing, approach. The KnowBots system demonstrates that agent technology can successfully work in place of a human facilitator to give immediate response while a student is actually working out solutions.

Recommendations for Future Study

1. In order to perform a future formative study on effects of using KnowBots, I recommend designing a tighter experiment design. There might be a better way to investigate the trade-off or cost-effectiveness of adopting intelligent agent techniques like the KnowBots to an on-line learning environment.
2. The results of this study show that it will be worth conducting further study on the effects of the intelligent agents like KnowBots.

Recommendations for Future Development

1. More consistency is needed between the instructions given by the learning material and the instructions given by the KnowBots
2. Provide participants with explicit directions on how to use KnowBots effectively before the workshop begins
3. Provide an easy way for participants to ask for additional help, when needed

4. Monitor the learners' progress more frequently possibly by a human facilitator or by using scheduled KnowBots
5. Develop an administrator or maintenance page for facilitators to update, modify, and monitor the progress of the participants.

This is an exploratory study that initially attempted to investigate possible effects of adopting intelligent agent techniques to an on-line learning environment, specifically to the ALN workshop. I hope that the results of this study will contribute some knowledge or guidelines of how to adopt this technology to the on-line learning community in the future.

Future research in this area needs to address the theoretical assumptions about measures of other possible impacts from the use of intelligent agents to an on-line learning, if the traditional outcome indicators suffer. It is especially important that attempts to replicate this study also try to randomly select the treatment to the population. It may well be that negative outcomes on traditional indicators can be associated with a positive impact of adopting intelligent agent techniques to the on-line learning society as a whole.

APPENDIX A

Table A2 Table of Student's *t* Distribution

Two-tailed	.80	.50	.20	.10	.05	.02	.01	.001
One-tailed	.40	.25	.10	.05	.025	.01	.005	.0005
p	**.60**	**.75**	**.90**	**.95**	**.975**	**.99**	**.995**	**.9995**
df								
I	.325	1.000	3.078	6.314	12.706	31.821	63.657	636.619
2	.289	.816	1.886	2.920	4.303	6.965	9.925	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	4.437
12	.259	.695	1.356	1.782	2.179	2.691	3.055	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.797	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.707
27	.256	.694	1.314	1.703	2.052	2.473	2.771	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	3.460
120	.254	.677	1.289	1.658	T980	2.358	2.617	3.373
∞	.253	.674	1.282	1.645	-1.960	2.326	2.576	3.291

Table A16 Table of Critical Values for Pearson *r*

		One-tailed level of significance		
	.05	**.025**	**.01**	**.005**
		Two-tailed level of significance		
	.10	**.05**	**02**	**.01**
df = n-2				
	.988	.997	.9995	.9999
2	.900	.950	.980	.990
3	.805	.978	.934	.959
4	.729	.811	.882	.911
5	.669	.754	.833	.874
6	.622	.707	.789	.834
7	.582	.666	.750	.798
8	.549	.632	.716	.765
9	.521	.602	.685	.735
10	.497	.576	.658	.708
11	.476	.553	.634	.684
12	.458	.532	.612	.661
13	.441	.514	.592	.641
14	.426	.497	.574	.623
15	.412	.482	.558	.606
16	.400	.468	.542	.590
17	.389	.456	.528	.575
18	.378	.444	.516	.561
19	.369	.433	.503	.549
20	.360	.423	.492	.537
21	.352	.413	.482	.526
22	.344	.404	.472	.515
23	.337	.396	.462	.505
24	.330	.388	.453	.496
25	.323	.381	.445	.487
26	.317	.374	.437	.479
27	.311	.367	.430	.471
28	.306	.361	.423	.463
29	.301	.355	.416	.456
30	.296	.349	.409	.449
35	.275	.325	.381	.418
40	.257	.304	.358	.393
45	.243	.288	.338	.372
50	.231	.273	.322	.354
60	.211	.250	.295	.325
70	.195	.232	.274	.302
80	.183	.217	.256	.283
90	.173	.205	.242	.267
100	.164	.195	.230	.254

APPENDIX B

Table B-1 Data Table of Number of Times Using the KnowBots, Number of Assignment Completed, and Number of Visits to the Learning Material by the Participants of January-99 Session

User	Number of Visits	Number of Assignments Completed	Total KnowBots Use
1	30	4	19
2	57	5	23
3	54	0	14
4	68	2	16
5	2	0	13
6	4	1	11
7	264	8	29
8	32	8	36
9	33	4	15
10	38	8	26
11	39	4	18
12	60	2	14
13	58	4	20
14	15	2	12
15	74	5	18
16	118	8	19
17	23	3	19
18	3	0	12
19	79	2	27
20	39	5	14
21	48	5	27
22	25	8	41
23	62	6	34
24	56	8	13
25	27	2	12
26	62	8	19
27	22	0	13
28	29	4	11
29	15	2	11
30	33	8	26
31	4	0	11
32	2	1	12
33	3	0	13
34	44	8	22
35	5	0	6
36	88	5	27
37	21	2	13

38	52	8	24
39	26	6	22
40	64	5	47
41	40	8	50
42	47	8	40
43	21	2	15
44	74	8	23
45	29	3	25
46	2	0	9
47	72	8	36
48	58	8	19
49	38	8	29
50	56	8	19
51	36	4	16
52	79	8	27
53	29	8	30
54	30	2	10
55	16	3	18
56	43	8	33
57	40	5	20
58	31	8	22
59	53	3	22
60	57	8	54
61	30	6	48
62	9	8	42

Table B-2 Data Table of Number of Time Using the KnowBots, Number of Assignment Completed, and Number of Visits to the Learning Material by the Participants of September-99 Session

User	Number of Visits	Number of Assignments Completed	Total KnowBots Use
1	52	8	24
2	3	1	9
3	25	0	11
4	20	2	11
5	15	8	23
6	36	3	15
7	35	8	22
8	4	1	9
9	15	2	19
10	18	4	22
11	29	2	10
12	27	5	24
13	1	0	10
14	15	5	19
15	35	4	15
16	8	2	13
17	22	1	14
18	3	3	7
19	3	0	10
20	24	4	22
21	50	4	23
22	5	1	9
23	12	8	31
24	15	0	10
25	3	0	10
26	12	2	2
27	32	3	13
28	18	1	11
29	14	4	20
30	20	3	11
31	14	2	8
32	6	4	18
33	52	5	33
34	55	4	20
35	15	8	35
36	102	8	27
37	17	2	12
38	31	2	11
39	1	1	8
40	6	0	11
41	59	8	26

42	44	8	62
43	32	3	23
44	20	2	12
45	11	2	12
46	25	2	12
47	34	3	17
48	16	3	14
49	49	3	12
50	1	0	10
51	13	2	10
52	53	5	25
53	19	4	18
54	28	3	15
55	43	2	17
56	20	2	15
57	8	0	10
58	118	1	18
59	4	1	14
60	45	4	15
61	7	1	6
62	62	4	17
63	66	8	25
64	26	2	14
65	5	2	13
66	14	1	11
67	59	7	35
68	10	2	14
69	28	4	28
70	14	2	15
71	7	1	10
72	3	1	8
73	37	8	26
74	28	2	15
75	130	7	22
76	40	4	15
77	18	2	12
78	5	2	8
79	60	8	25
80	29	5	14
81	41	5	34
82	11	2	9
83	7	2	8
84	61	5	27
85	6	1	17
86	77	8	25
87	86	8	54
88	198	8	44

89	33	4	20
90	64	4	20
91	31	8	19
92	13	2	15
93	36	2	37
94	38	2	21

APPENDIX C

Table C-1 Data Table for Correlation Test on Number of Times Using the KnowBots and the Status of Assignment Completion (Individual) by the Participants of January-99 Session

User	C1	C2	C3	C4	C5	C6	C7	C8	A1	A2	A3	A4	A5	A6	A7	A8
1	3	4	4	4	4	0	0	0	1	1	1	1	0	0	0	0
2	2	4	4	5	8	0	0	0	1	1	1	1	1	0	0	0
3	3	5	0	4	2	0	0	0	0	0	0	0	0	0	0	0
4	3	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
5	1	4	5	4	2	0	0	0	1	1	0	0	0	0	0	0
6	3	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
7	1	4	0	4	2	0	0	0	1	0	0	0	0	0	0	0
8	4	5	4	6	5	1	1	3	1	1	1	1	1	1	1	1
9	3	3	11	3	12	1	2	1	1	1	1	1	1	1	1	1
10	1	2	4	4	4	0	0	0	1	1	1	1	0	0	0	0
11	2	4	4	4	5	2	3	2	1	1	1	1	1	1	1	1
12	1	2	6	5	4	0	0	0	1	1	1	1	0	0	0	0
13	3	1	4	4	2	0	0	0	1	1	0	0	0	0	0	0
14	1	2	11	4	2	0	0	0	1	1	1	1	0	0	0	0
15	1	1	4	4	2	0	0	0	1	1	0	0	0	0	0	0
16	2	3	4	7	2	0	0	0	1	1	1	1	1	0	0	0
17	1	2	5	4	4	1	1	1	1	1	1	1	1	1	1	1
18	3	3	7	4	2	0	0	0	1	1	1	0	0	0	0	0
19	2	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
20	3	4	11	6	3	0	0	0	1	1	0	0	0	0	0	0
21	2	3	2	3	4	0	0	0	1	1	1	1	1	0	0	0
22	2	2	5	3	15	0	0	0	1	1	1	1	1	0	0	0
23	2	5	12	5	11	1	4	1	1	1	1	1	1	1	1	1
24	4	6	12	7	3	1	1	0	1	1	1	1	1	0	1	0
25	2	3	1	2	2	1	1	1	1	1	1	1	1	1	1	1
26	1	3	0	4	4	0	0	0	1	1	0	0	0	0	0	0
27	2	2	2	3	6	2	1	1	1	1	1	1	1	1	1	1
28	3	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
29	0	4	0	0	4	1	1	1	0	0	0	0	1	1	1	1
30	3	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
31	3	3	0	3	2	0	0	0	1	1	0	0	0	0	0	0
32	3	3	6	4	2	3	3	2	1	1	1	1	1	1	1	1
33	3	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0
34	3	4	0	3	2	0	0	0	1	0	0	0	0	0	0	0
35	3	4	0	4	2	0	0	0	0	0	0	0	0	0	0	0
36	1	2	6	3	3	2	1	4	1	1	1	1	1	1	1	1
37	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0
38	2	3	5	3	14	0	0	0	1	1	1	1	1	0	0	0
39	4	5	0	4	0	0	0	0	1	1	0	0	0	0	0	0

40	4	2	2	5	6	1	1	3	1	1	1	1	1	1	1	1
41	1	2	6	5	5	1	0	2	1	1	1	1	1	0	0	1
42	3	3	12	24	5	0	0	0	1	1	1	1	1	0	0	0
43	2	3	25	3	12	3	1	1	1	1	1	1	1	1	1	1
44	3	2	16	3	13	1	1	1	1	1	1	1	1	1	1	1
45	4	7	0	4	0	0	0	0	1	1	0	0	0	0	0	0
46	1	3	1	3	11	2	1	1	1	1	1	1	1	1	1	1
47	3	5	10	5	2	0	0	0	1	1	0	1	0	0	0	0
48	1	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0
49	5	8	8	4	7	1	1	2	1	1	1	1	1	1	1	1
50	3	4	2	4	3	1	1	1	1	1	1	1	1	1	1	1
51	1	2	13	4	6	1	1	1	1	1	1	1	1	1	1	1
52	3	2	4	4	3	1	1	1	1	1	1	1	1	1	1	1
53	3	1	3	5	4	0	0	0	1	1	1	1	0	0	0	0
54	4	4	3	4	6	2	1	3	1	1	1	1	1	1	1	1
55	3	4	4	6	10	1	1	1	1	1	1	1	1	1	1	1
56	3	3	0	4	0	0	0	0	1	1	0	0	0	0	0	0
57	3	3	4	4	4	0	0	0	1	1	1	0	0	0	0	0
58	4	3	9	8	6	1	1	1	1	1	1	1	1	1	1	1
59	2	3	4	4	7	0	0	0	1	1	1	1	1	0	0	0
60	3	2	6	4	4	1	1	1	1	1	1	1	1	1	1	1
61	3	3	4	8	4	0	0	0	1	1	1	0	0	0	0	0
62	4	6	8	13	18	3	1	1	1	1	1	1	1	1	1	1
63	5	5	6	9	21	2	0	0	1	1	1	1	1	1	0	0

Note: C*n* = number of times the participant using the KnowBots for Assignment #*n*,

A*n* = status of assignment *n* completion: 1= complete, and 0= incomplete

Table C-2 Data Table for Correlation Test on Number of Times Using the KnowBots and the Status of Assignment Completion (Individual) by the Participants of September-98 Session

User	C1	C2	C3	C4	C5	C6	C7	C8	A1	A2	A3	A4	A5	A6	A7	A8
1	2	4	10	3	2	0	2	1	1	1	1	1	1	1	1	1
2	3	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
3	4	4	0	1	2	0	0	0	0	0	0	0	0	0	0	0
4	4	4	2	1	1	0	0	0	1	1	0	0	0	0	0	0
5	4	4	0	1	2	0	0	0	1	1	0	0	0	0	0	0
6	4	4	1	1	7	4	1	1	1	1	1	1	1	1	1	1
7	4	5	3	1	2	0	0	0	1	1	1	0	0	0	0	0
8	2	4	2	1	10	1	1	1	1	1	1	1	1	1	1	1
9	3	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
10	4	4	8	1	2	0	0	0	1	1	0	0	0	0	0	0
11	2	4	11	3	2	0	0	0	1	1	1	1	0	0	0	0
12	2	5	0	1	2	0	0	0	1	1	0	0	0	0	0	0
13	8	6	2	5	3	0	0	0	1	1	1	1	1	0	0	0
14	2	5	5	4	2	0	1	0	1	1	1	1	1	0	0	0
15	5	5	1	2	2	0	0	0	1	1	1	1	0	0	0	0
16	6	5	0	1	1	0	0	0	1	1	0	0	0	0	0	0
17	0	0	0	0	3	0	2	2	1	0	0	0	1	0	0	1
18	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
19	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
20	3	4	8	1	2	1	2	2	1	1	1	0	0	1	0	0
21	3	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
22	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
23	2	5	8	4	7	2	1	2	1	1	1	1	1	1	1	1
24	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	0
26	6	4	1	1	1	0	0	0	1	1	1	0	0	0	0	0
27	5	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
28	2	4	9	3	2	0	0	0	1	1	1	1	0	0	0	0
29	3	4	2	1	1	0	0	0	1	1	1	0	0	0	0	0
30	2	4	0	1	1	0	0	0	1	1	0	0	0	0	0	0
31	4	4	8	1	1	0	0	0	1	1	1	1	0	0	0	0
32	4	5	18	5	1	0	0	0	1	1	1	1	1	0	0	0
33	2	4	9	2	3	0	0	0	1	1	1	1	0	0	0	0
34	4	4	11	2	10	1	1	2	1	1	1	1	1	1	1	1
35	2	4	10	1	2	2	4	2	1	1	1	1	1	1	1	1
36	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
37	6	4	0	1	1	0	0	0	1	1	0	0	0	0	0	0
38	2	4	2	1	2	0	0	0	1	1	0	0	0	0	0	0
39	2	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
40	4	5	0	1	1	0	0	0	0	0	0	0	0	0	0	0
41	3	5	8	3	3	1	1	2	1	1	1	1	1	1	1	1

42	3	9	3	12	30	3	1	1	1	1	1	1	1	1	1	1
43	3	6	11	1	2	0	0	0	1	1	1	0	0	0	0	0
44	3	4	3	1	1	0	0	0	1	1	0	0	0	0	0	0
45	4	4	1	1	2	0	0	0	1	1	0	0	0	0	0	0
46	5	5	0	1	1	0	0	0	1	1	0	0	0	0	0	0
47	2	4	8	1	2	0	0	0	1	1	0	1	0	0	0	0
48	5	5	2	1	1	0	0	0	1	1	1	0	0	0	0	0
49	4	5	1	1	1	0	0	0	1	1	1	0	0	0	0	0
50	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
51	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
52	2	6	0	1	1	0	0	0	1	1	0	0	0	0	0	0
53	2	4	6	7	6	0	0	0	1	1	1	1	1	0	0	0
54	5	5	3	3	2	0	0	0	1	1	1	1	0	0	0	0
55	2	4	4	1	4	0	0	0	1	1	1	0	0	0	0	0
56	5	5	4	1	2	0	0	0	1	1	0	0	0	0	0	0
57	3	4	2	4	2	0	0	0	1	1	0	0	0	0	0	0
58	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
59	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
60	8	5	3	1	1	0	0	0	0	1	0	0	0	0	0	0
61	5	4	2	1	2	0	0	0	0	1	0	0	0	0	0	0
62	5	5	1	2	2	0	0	0	1	1	1	1	0	0	0	0
63	2	2	0	1	1	0	0	0	1	0	0	0	0	0	0	0
64	5	4	1	1	2	1	2	1	1	1	0	0	0	1	0	1
65	4	5	6	2	4	1	1	2	1	1	1	1	1	1	1	1
66	4	5	3	1	1	0	0	0	1	1	0	0	0	0	0	0
67	6	5	0	1	1	0	0	0	1	1	0	0	0	0	0	0
68	4	4	1	1	1	0	0	0	0	1	0	0	0	0	0	0
69	6	6	3	10	4	3	1	2	1	1	1	1	1	1	0	1
70	6	6	0	1	1	0	0	0	1	1	0	0	0	0	0	0
71	2	4	19	2	1	0	0	0	1	1	1	1	0	0	0	0
72	5	4	4	1	1	0	0	0	1	1	0	0	0	0	0	0
73	4	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
74	2	4	0	1	1	0	0	0	1	0	0	0	0	0	0	0
75	4	7	5	2	4	2	1	1	1	1	1	1	1	1	1	1
76	4	4	5	1	1	0	0	0	1	1	0	0	0	0	0	0
77	2	4	3	2	8	2	1	0	1	1	1	1	1	1	1	0
78	2	4	5	1	3	0	0	0	1	1	1	1	0	0	0	0
79	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
80	5	4	0	1	2	0	0	0	1	1	0	0	0	0	0	0
81	2	4	0	1	1	0	0	0	1	1	0	0	0	0	0	0
82	1	2	2	13	4	1	1	1	1	1	1	1	1	1	1	1
83	0	4	2	5	3	0	0	0	1	1	1	1	1	0	0	0
84	5	5	11	2	7	1	2	1	1	1	1	1	0	0	0	1
85	2	4	1	1	1	0	0	0	1	1	0	0	0	0	0	0
86	2	4	0	1	1	0	0	0	1	1	0	0	0	0	0	0
87	3	6	13	1	2	1	0	1	1	1	1	1	0	0	0	1
88	2	4	8	1	2	0	0	0	1	0	0	0	0	0	0	0

89	5	5	2	4	5	2	1	1	1	1	1	1	1	1	1	1
90	4	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0
91	2	4	30	5	8	3	1	1	1	1	1	1	1	1	1	1
92	3	5	13	5	14	1	1	2	1	1	1	1	1	1	1	1
93	5	6	5	2	2	0	0	0	1	1	1	1	0	0	0	0
94	3	5	6	3	3	0	0	0	1	1	1	0	1	0	0	0
95	3	5	4	2	2	1	1	1	1	1	1	1	1	1	1	1
96	7	6	0	1	1	0	0	0	1	1	0	0	0	0	0	0
97	2	4	4	6	21	0	0	0	1	1	0	0	0	0	0	0
98	4	7	7	1	2	0	0	0	1	1	0	0	0	0	0	0

Note: C*n* = number of times the participant using the KnowBots for Assignment #*n*,

A*n* = status of assignment #*n* completion: 1= complete, and 0= incomplete

APPENDIX D

SAMPLE OF COMPLEXITY RATING ON FACILITATION MESSAGES

This section illustrates samples of facilitation messages where the complexity level was assigned to approximate the facilitation time.

Response to the question below was rated the 5-complexity.

Question: I am trying to figure out how Front Page saves frame pages. I can't find anything in the on-line help and the literature is just as thin on the subject. When I want to save a page with frames I seem to get duplicate files and I am not sure what URL or title to give them. I have lost hours of work thorough not saving the pages correctly. Can you point me to a resource or give some advice. Many thanks, Mike

Response: Assume you created a new page using frames with a banner frame, a table of content frame and a main frame. FP will save the new page in a file with the definition of the frameset. This include the size of each frame, their name (these name are use to 'target' links in a specific frame) and the initial page that the frame will contain. When you will save this page you will choose a name

Look at the code t below.

Here we have 2 framesets. The first one divide your page horizontally. The second divide the second row of the first set into 2 vertical frames.

Comment: First frame set: 2 rows. The top row has a height of 64 pixels (64), the second uses the rest of the page (*). The name of the first frame is 'Banner' and it contains the file 'banner.htm' when the page is open.

```
<frameset rows="64,*">
  <frame name="banner" scrolling="no" noresize  src="banner.htm">
```

Comment: second frameset definition. 2 columns . The first column named 'contents' has a width of 150 pixels, the second named 'main' uses the rest of the page width.

```
  <;frameset cols="150,*">
   <frame name="contents"  src="content.htm">
    <frame name="main" src="page_2.htm">
  </frameset>
```

<;noframes>

<body>

<p>This page uses frames, but your browser doesn't support them.

</body>

</noframes>

</frameset>

The code of this page can not be edited in FrontPage editor. You can edit it using Notepad.

After you define your frame set you just have to work on the files that will be displayed in the different frames. Always target a link to the correct frame (target="frameName").

You can easily modify any element of the frameset by opening the frameset page in FP editor. You can resize the frame just by dragging the borders. Select a frame and right click and select Frame properties. You can change the name, the initial page.

Note: that this particular message and response are obtained from the conferencing system of the May-98 session (did not use KnowBots). The response is rated the 5 complexity because the time that the facilitator must have spent to look for errors in the HTML code in the participant's course web pages by hand. However, this type of question was reduced when using the KnowBots in the later sessions because the KnowBots automated tasks that examining the correctness of using HTML codes.

Response to the question about using advanced media to the participant's on-line course below was rated the 4-complexity level.

Question: Is RealPublisher(G2) compatible with the present aln configuration? I'm trying to use Real Publisher (G2) to upload my html, .ram/.rpm and .rm files in the appropriate servers/directories per the RealPublisher- publish to the Web wizard. I log on to www.aln.org okay but it cannot find my ws_sbristol directory file? -- Scott

Response: Scott, Interesting observation. The Real G2 system by Real Networks just recently released their Beta 2. Shortly following G2 Publisher was released. To be quite honest, I didn't even realize a G2Publisher had been released and do not know what type of settings one can tune it to. The problem with us supporting G2 right now is that it is still in Beta mode, albeit second

Beta. I am assuming that it is still in Beta mainly because they have not released a version for MACs yet because it seems to work fine for PCs. As many participants use the MAC in this course we did not feel that the server should be updated to G2 (and they did not have the publisher out yet). When one encodes a file with the G2 Beta 2 you can select the target audience. In the Publisher there may be different settings that you can change that allows you to publish to a non-G2 server. The problem with G2 is that it now supports a new feature that degrades the presentation as more and more people access it simultaneously, first the video becomes less clear then the video drops leaving only the audio. This is not a feature that is available for the 5.0 version. If RealPublisher allows you to alter this setting you should do so. G2 also supports SMIL, which 5.0 does not. Until they come out with the MAC version of G2 and it no longer becomes Beta we will upgrade our servers to the newest version. -- Jason Mann, ALN Web Group

Response to the question below was rated the 3-complexity level:

Question: I have done a little work on Assignment #6 by trying to put a guestbook for comments on my site. Problem is it doesn't capture all the comments and the wizard format has text that tell the user to "refresh" their site to see their comment. And it doesn't work! Perhaps I messed something up on the guestlog file? Tried putting a navbar just on this page and couldn't do that either (without linking it in the navigation view on FP Explorer and then it's a menu item on every page--don't want that). So I simply put a button for "Home" on the page. Not very elegant. Any suggestions? Finally, when "previewing" a page in FP Editor, the page DOES NOT LOOK EXACTLY AS THE PUBLISHED PAGE LOOKS WHEN ACCESSING IT FROM A NORMAL BROWSER. Example--I have a 3-cell table on index.htm that I want evenly spaced on the bottom of the page. When I make adjustments to cell width to space them evenly, they do not (DO NOT) space evenly from a normal browser but "crunch up" the right-hand cell. Help? Off now to Benin. More when I return! Ron

Response: Ron, I looked at your guestbook and ran into the same problem, upon reloading the new comments did not appear. I went into FrontPage editor and everything appears to be set up correctly. I ended up resolving the problem by removing the webbot page, and replacing it. The form works as follows. The text box get saved as an htm file called guestlog.htm. Everything was saving correctly in this file so the transaction from the form to the guestlog was working. On the guestbook.htm page the guestlog page is inserted or nested into the bottom of the form. When you move over the comments in frontpage editor you should notice that curser turns to a webbot curser. This tells you that a FrontPage component was added. I selected and deleted this component, then I added it again. You do this by going to INSERT then FRONTPAGE COMPONENT, when the pop up menu appears you select INCLUDE PAGE, then browse to your page to be nested. This page MUST be within your frontpage web for it to work correctly. After doing the above actions your page now works correclty. The above method is how frontpage creates the guestbook and discussion webs. I have no explanation for why the guestbook was not working properly, Hopefully the problem is now resolved for good. You might want to add wrap="virtual" in the html for the text box, it makes typing a message a lot easier. I also included a URL and my email by typing exactly what is displayed. NAVIGATION BAR: The navigation bar reads the Navigation view, so there is no way around not having what is there displayed. You can select the level to be displayed by going into navigation properties. Double click on the navigation bar to get to this menu. TABLE: You seem to have this under control. You must remember that you need to adjust both the cell widths and the table width. -- Jason Mann, ALN Web Group

Response to the question below was rated the 2-complexity level:

Question: Jason-is there an easier way to stop getting emails from threads than having to go to each and unclicking the box at the bottom of each of one's messages about receiving emails? That's a pain to do! And it seems that when one creates a reply in a thread, the default is to check "Notify me by email about all messages posted in this thread" which is something that you might want to point out to those of us who DO NOT WANT more emails!!!!! Ron

Response: Unfortunately, no. You must go back to all previously posted messages and unclick the box saying "Notify me by email about all messages posted in this thread". However, this IS NOT the default. Post a new message without this marked and every new message you post after that will not have it checked. I do not know why Allaire put this feature in, it is very frustrating and confusing. I would ignore this option, and the other two at the bottom of the message window. Instead subscribe to threads by clicking on the circle next to the threads and then select "notify me by email" in the OPTIONS menubar. -- Jason Mann, ALN Web Group

Response to the question below was rated the 1-complexity level:

Question: I would like to go through much of the materials of this course again and would like to know if the materials will stay accessible and for how long?

Response: Everything will be deleted January 1st. This includes your webs and access to the on-line information. -- Jason Mann, ALN Web Group

APPENDIX E

THE SURVEY QUESTIONNAIRE

"Getting Started Creating Online Courses" Workshop/Checker Survey

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1. If you did not start the workshop, please tell us why, and answer only questions relevant to you:

2. **Basic information:**

E-mail

First name

Last name

Position

Affiliation

Area represented ☐ Education ☐ Administration ☐ Nursing ☐ Arts/Science ☐ Community College

☐ Medicine ☐ Engineering ☐ Training ☐ Business/Management

☐ Trade Association

☐ Government ☐ Other (specify):

3. **Workshop in general**

Please rate the following items (scale 1=very low, very poor, not at all; 2=fair; 3=adequate; 4=good; 5=very high, excellent, very much) and answer the questions below about the workshop.

		Very low/ Poor 1	2	3	4	Very high/ Excellent 5
3.1.	How would you rate the overall quality of workshop?	☐	☐	☐	☐	☐
3.2.	Would you recommend this workshop to a friend?	☐	☐	☐	☐	☐
3.3.	How would you rate the support activities of the workshop (i.e., facilitators)?	☐	☐	☐	☐	☐
3.4.	Were the instructions of the on-line material clear and easy to follow?	☐	☐	☐	☐	☐

3.5. How would you rate the clarity of the assignments?

3.6. Did this workshop live up to your initial expectations?

3.7. Where did you hear about our workshop? (Check all that apply)

- ☐ Web search
- ☐ Word of mouth
- ☐ Annual ALN Conference
- ☐ Sloan Foundation
- ☐ Listserv
- ☐ Other, please specify

3.8. What were your reasons for initially taking this workshop?

3.9. What were the best features of the workshop? Why?

3.10. What were the worst features of the workshop? Why? And what should we do to improve the workshop?

3.11. What would be other topics for workshops that might interest you?

3.12. Other comments are welcome:

4. **Checkers:**

During your session of the workshop, you received help from the Checkers in order to help you to complete the assignments and the workshop. Please rate the following about the Checkers (scale 1=very low, very poor, not at all; 2=fair; 3=adequate; 4=good; 5=very high, excellent, very much), and answer the questions below.

	Very low/ Poor 1	**2**	**3**	**4**	**Very high/ Excellent 5**
4.1. Did the Checkers help you to complete the assignment faster?					
4.2. How would you rate the Checkers' help to motivate you to complete the assignment?					
4.3. Did the Checkers help improve access to the on-line material?					
4.4. Were the instructions given by the Checkers effective?					
4.5. Was the information given by the Checkers consistent with the information given in the on-line material?					
4.6. Did the Checkers help improve your confidence to complete the workshop?					
4.7. How well did the Checkers help you to complete the assignments?					
4.8. Did the Checkers help reduce time to learn the on-line material?					

Please rate the helpfulness of these features of the Checkers:

	Very low/ Poor 1	**2**	**3**	**4**	**Very high/ Excellent 5**
4.9. Email notification/reminder of the assignment					
4.10. Ability to check the assignment at any time I want (on-demand Checkers)					
4.11. The report and the direction the Checkers gave to help complete the assignment					

4.12. Other features that are not listed above that you liked about the Checkers, or additional comments about your ratings above:

4.13. If you did not like the Checkers or have never used the Checkers, please explain why.

Please rate the extent to which the following features motivated you to complete the assignments

	Very low/ Poor 1	2	3	4	Very high/ Excellent 5
4.14. Encouraging messages sent to me by email	◻	◻	◻	◻	◻
4.15. The explicit directions in the report after checking my assignment	◻	◻	◻	◻	◻
4.16. Reminding me to complete the assignment before the due dates	◻	◻	◻	◻	◻

4.17. If there are other features not listed above that motivated you to complete the assignments, please specify:

4.18. How did the checker change the way you learn?

4.19. In what way did the Checkers help you to complete the assignments and the workshop?

Submit Form Reset Form

APPENDIX G

REQUIREMENTS FOR CERTIFICATE OF COMPLETION OF THE ALN WORKSHOP

Assignment #1: Post at least two messages in forum Assignment #1.

1. First posting: A message that introduce yourself to the group. Title one posting, "Introducing" then your first and last names (e.g., Introducing Jane Smith). This will be your personal introduction message.
2. Second posting: A reply to someone else introduction.

Assignment #2: Review at least 3 courses. Post at least one review in each of three different threads (course titles) in forum Assignment #2.

Assignment #3: Put up your personal homepage, written in HTML, on the workshop server. Also post at least two messages in forum Assignment #3.

1. The homepage must be in your root directory (ws_username) and named with your username followed by the extension .htm (e.g., ws_smithjm/smithjm.htm). It must contain at least one each of the following:
   - at least 2 different heading levels
   - 1 numbered list
   - 1 bulleted list
   - 1 hyperlink to another site or page
   - 1 hyperlink to the workshop homepage
   - 1 mailto hyperlink (mailto:)
   - 1 horizontal line <hr>
   - Either a photo of yourself or another image
2. The 2 postings to the workshop Forum Assignment # 3 should be as follows: A first posting titled your name's homepage (e.g., Jane Smith's Homepage), with a link to your homepage (your name). A second posting will be comments on another participant's home page).

Assignment #4: Put up your course homepage and at least two additional course pages linked from the course homepage on the workshop server, all developed using Microsoft Front Page. Also post at least two messages in forum Assignment # 4.

1. The course homepage must be named index.htm and located in the root directory of your Web (e.g., /ws_smithjm/index.htm). At least one each of the following must appear somewhere in the three pages:
   - 1 hyperlink (e.g., to the institution that offers the course)
   - 1 heading
   - Some text
   - Some text using another font or color
   - 1 list
   - 1 table
   - 1 graphic
   - 1 hyperlink to a page within your web
   - 1 hyperlink to your personal homepage developed in Assignment # 3

2. Post at least 2 messages in Forum Assignment #4
   - A first posting titled your name's Course (e.g., Jane Smith's Course), with a link to your course homepage (your name's course)
   - A second posting will be the comments regarding the course of another workshop participant.

Assignment #5: Create pages using advanced features of FrontPage and post the hyperlinks of these pages in Forum Assignment #5. All these pages must be linked from the index.htm (homepage).

1. Produce all of the following and place them in your directory (e.g., ws_smithjm). This may be a reformatted version of your course homepage or another page in your web.
   - A page that uses Frames
   - A Form and a result file
   - An Image Map
   - A web based on a FrontPage theme

- A web that uses a FrontPage navigation bars or shared borders

2. Post a message in workshop forum Assignment # 5 with a descriptive title (e.g., Image Map) that includes links to the results of your work for each of the above.

Assignment #6: Create at least 3 pages using Advanced Media and post the hyperlinks of these pages in Forum Assignment #6

1. Produce 3 of the following and place them in your directory (e.g., ws_smithjm)
    - A page built using a wizard or template from FrontPage (e.g., feedback form, guestbook)
    - A PowerPoint presentation, converted to HTML, and inserted in your course
    - An addition to your PowerPoint presentation above that includes Real Audio using the Real Audio Plugin (or Real Presenter if you have it)
    - An audio or video presentation to your course that does not use PowerPoint
    - A FrontPage multiple choice quiz/form
2. Post a message in workshop forum Assignment #6 with a descriptive title (e.g., Audio/Video presentation) that includes links to the results of your work for 3 of the above.

Assignment #7: Build a discussion forum and post the hyperlinks of these pages in Forum Assignment #7

1. (PC Only)
    - Build a sample discussion forum page with FrontPage. Put it in your directory (e.g., ws_smithjm) and post a few messages in your new forum.
    - Post a message in the workshop forum Assignment #7titled <your name>'s Discussion Forum (e.g., Jane Smith's Discussion Forum), with a link to your discussion page.
    - Post a message into the workshop forum Assignment #7 discussing the utility of Allaire Forums (that we are using for this workshop), and/or FrontPage conferencing system.
2. (MAC Only) Post a message into the workshop forum Assignment #7 discussing the utility of Allaire Forums (that we are using for this workshop), or another conferencing system.

Assignment #8: Try NetMeeting and discuss the use of a synchronous system.

1. Post a message to forum Assignment #8 stating the benefits of using a synchronous discussion for an on-line course and how you would use a synchronous discussion for your own on-line course.
2. You may optionally try out a synchronous discussion using NetMeeting (for PC) or another synchronous tool (chat tool) to gain experience.

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